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of
KNITTING

VOLUME II
(CIRCULAR KNITTING)

WILLIAM E. SHINN

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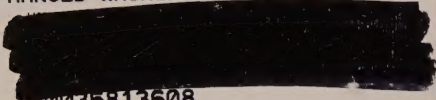


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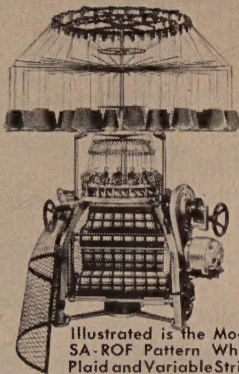
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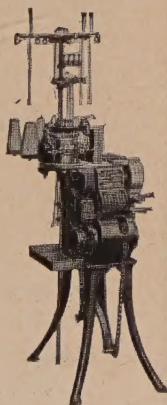
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by William E. Shinn

Head, Knitting Department,

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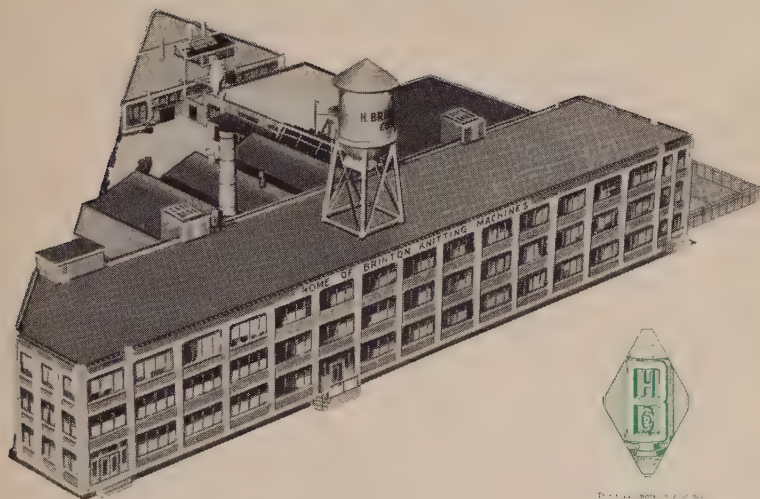
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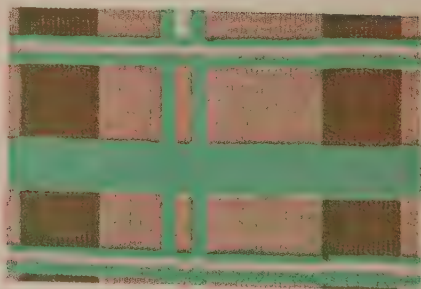
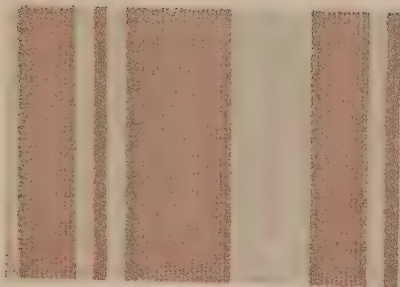
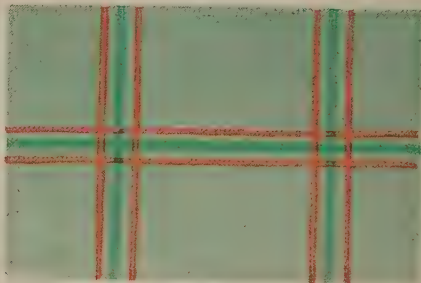
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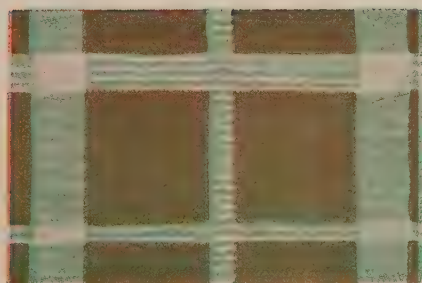
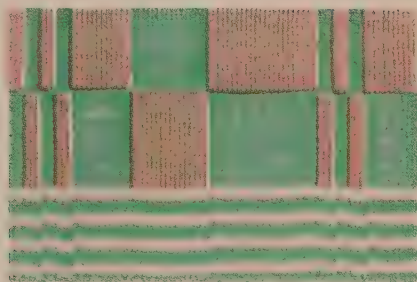
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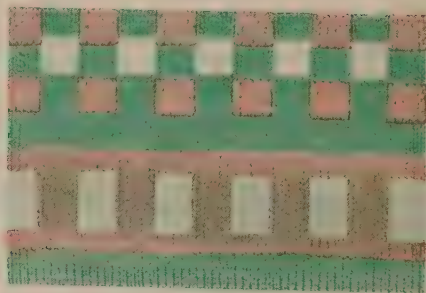
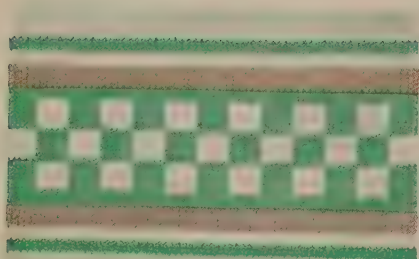
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PRINCIPLES OF KNITTING

Volume II

(CIRCULAR KNITTING)

By

WILLIAM E. SHINN

Head, Knitting Department

School of Textiles

North Carolina State College

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AUTHOR'S PREFACE

THE material included in this text has been selected and arranged with the object of providing a more advanced manual for students in textile schools and for others engaged in the production and operation of knitting machinery. The scope of *Principles of Knitting, Volume I*, was general and emphasis was placed on the elementary principles of hosiery machinery and hosiery knitting. In *Volume II*, the emphasis has been placed on the larger types of machines for knitted fabric production.

In the preparation of this manual, the author received valuable assistance from the engineering staffs of various machine building companies. Appreciation is expressed for help rendered by the following: Mr. H. W. Anderson, Vice-President of H. Brinton Co.; Mr. Joseph P. Vogt, President, Fidelity Machine Co.; Mr. W. R. Marsden, Scott & Williams, Inc.; Mr. F. B. Wildman, President, Wildman Mfg. Co.; Mr. W. A. Ingalls, President, Tompkins Bros. Co.; Abraham Abrams, Supreme Knitting Machine Co.; and Mr. N. J. Tellerman, Stop-Motion Devices Co.

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WILLIAM E. SHINN

Raleigh, N. C.
September, 1949

**Errata: On Pages 59 and 136 of this volume the
illustration should be inverted. - - Printer.**

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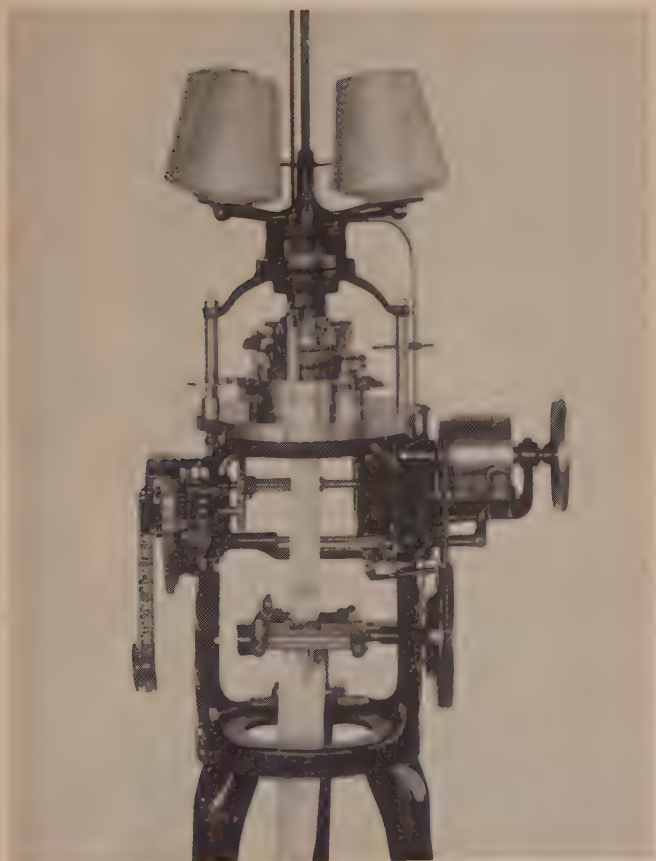
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Chapter I. Advanced Hosiery Rib Knitting

THE Universal ribber is adaptable to many uses and is capable of producing a variety of sizes by use of the same basic machine, so that it comes naturally by the name "Universal." The head, shown at Fig. 1, fits directly into the top of the retaining ring attached to the frame, and the cylinder fits in this head. The heads for cylinders from $2\frac{1}{4}$



The Fidelity Machine Co. French welt ribber.

to $4\frac{3}{4}$ inches in diameter are interchangeable into the retaining ring of the frame end, since the outside diameter of the section of the head fitting into the retaining ring is the

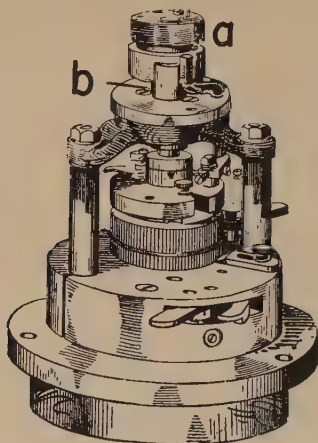


Fig. 1—Removable head.

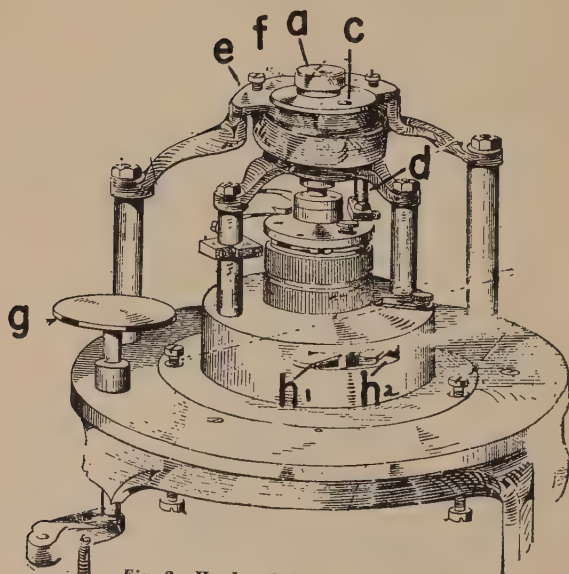


Fig. 2—Head and dogless attachment.

same for all sizes; thus no other parts of the machine are affected in changes. Heads for cylinders from five to seven inches in diameter likewise fit the same retaining ring and frame and may be substituted one for the other as in the smaller range of sizes.

The machine is equipped with a non-vibrating dogless attachment which eliminates vibrating latches and cylinder dogs. The main object of all dogless attachments is to provide a means for holding the dial and the dial stem stationary with a bracket or spider attached to the machine frame, and at the same time allow the yarn to be carried without hindrance around the dial stem with the revolving feed. This is accomplished on the Universal ribber as follows: *a* in Fig. 1 is an eccentric and locking collar on the dial stem *b*. When the head is in place the locking collar is surrounded by a thread guide ring *c*, as shown in Fig. 2. This ring is guided by a centering plate *e* and is made to revolve with the head by a driving pin *d*. Any tendency of the dial to move would cause the locking collar to revolve eccentrically. This is prevented by the centering plate, which makes it impossible to revolve the locking collar except upon its true center. This, however, does not affect the movement of the surrounding ring, which carries with it the yarn (or yarns) through passages such as *f* in Fig. 2.

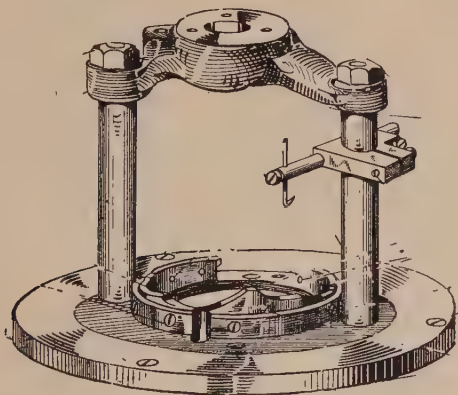


Fig. 3—Cam ring and cross bar.

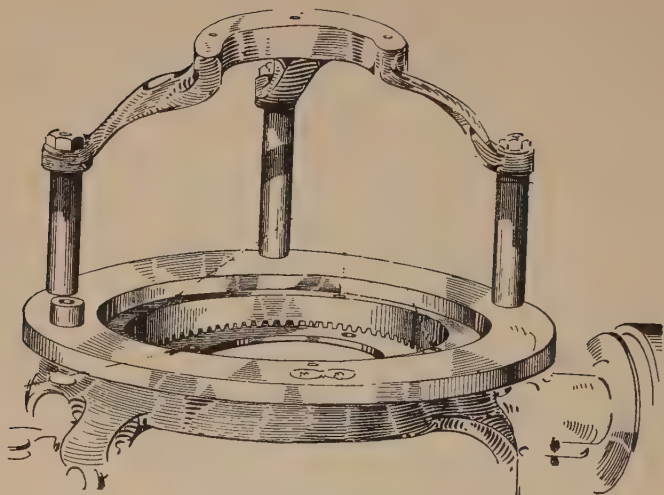


Fig. 4—Head and dogless spider.

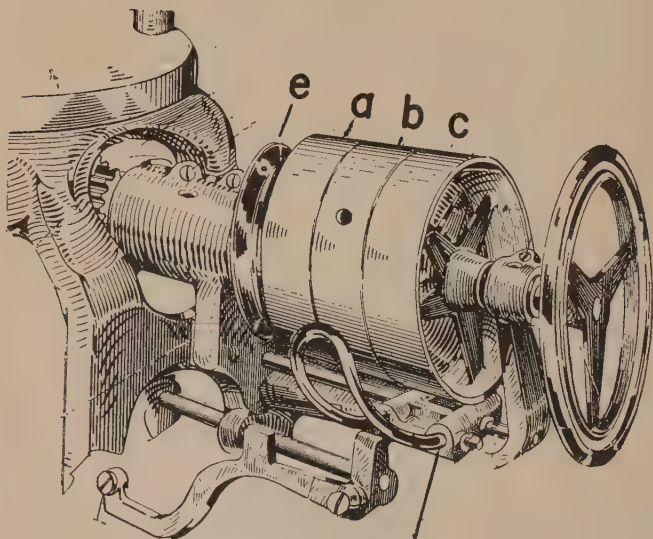


Fig. 5—Driving mechanism.

The driving system of the Universal ribber is a cleverly devised two-speed drive. It provides slow speeds for the

changes which take place in forming the loose course and the welt, and high speed for plain knitting. Its mechanism is attached to the frame by a bracket (see Fig. 5) and consists of a high-speed pulley *a*, a slow-speed pulley *b*, a loose pulley *c*, a hand wheel, a grooved pulley *c* for driving the fabric take-up mechanism, and a belt shifter. Fig. 6 shows the gearing. The bushing *b* contains a sleeve *f* which fits loosely on the main shaft and has attached to it gears *g* and *h*. Gear *h* meshes with the ring gear shown in Fig. 4 and drives the head at either of two speeds.

When the drive belt is on the high-speed pulley *a* (Fig. 7) power is transmitted through sleeve *f* (Fig. 6) and gear

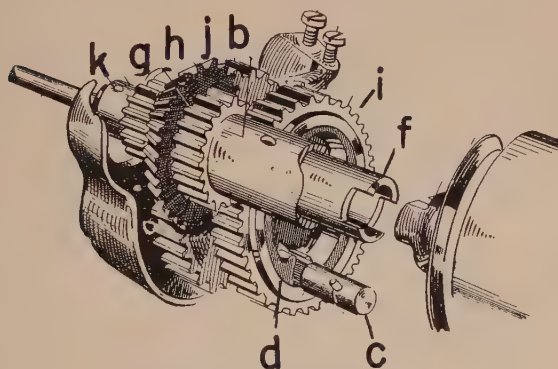


Fig. 6—Driving gear assembly.

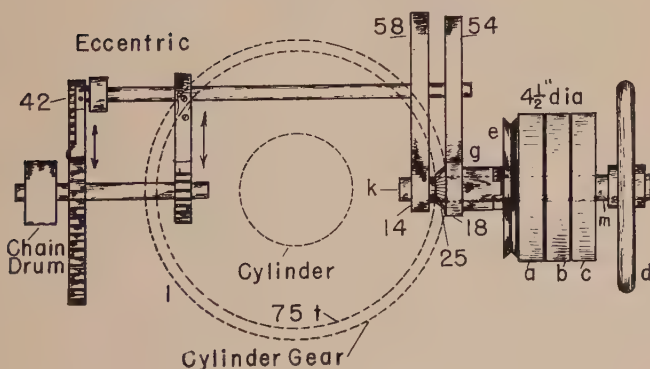


Fig. 7—Diagram of ribber gearing.

g direct to the cylinder gear. When the belt is on the slow-speed pulley *b* (attached rigidly to shaft *m*) power is transmitted through the shaft gears to the sleeve gear, bevel gear and the ring gear. It will be noted that the driving gears in this chain are smaller than the driven gears; consequently a step-down in speed is effected.

In speed calculations it may be noted that in Fig. 7 the number of teeth in each gear is indicated. Thus it is possible to find the speed of the cylinder when the pulley speed is known. For example, the pulley of the Universal ribber is being driven at 540 r.p.m.; find *a* (high speed of cylinder), *b* (slow speed of cylinder):

$$a. \quad \frac{540 \times 25}{75} = 180 \text{ r.p.m.}$$

$$b. \quad \frac{540 \times 14 \times 54 \times 25}{58 \times 18 \times 75} = 130.4 \text{ r.p.m.}$$

The cylinder used in machines from $2\frac{3}{4}$ to $4\frac{3}{4}$ inches in diameter is shown at *A*, Fig. 8. It is made of drop-forged, high-carbon steel turned to the proper size on a lathe and cut with vertical slots or tricks for carrying the needles. The number of tricks cut and the width of each depends upon the number of needles per inch the customer desires, as well as the thickness or gauge of needle to be used. The cylinder is cut with a recess *C* for receiving an eccentric adjusting stud *D* whereby the cylinder may be moved slightly forward or backward to facilitate needle alignment of cylinder and dial.

The dial shown at *B*, Fig. 8, is slightly smaller in diameter than the cylinder and is cut with radial slots equal in number to those in the cylinder. In some cases where the machine is to be used permanently for Richelieu rib (2-and-1) the dial may contain only half the number of slots of the cylinder. In many machines the gauge of needle used in the dial is finer than that of the cylinder. For example, a cylinder fitted with 36 gauge needles may be used with a dial fitted with 48 gauge needles.



Fig. 8—Cylinder and dial.

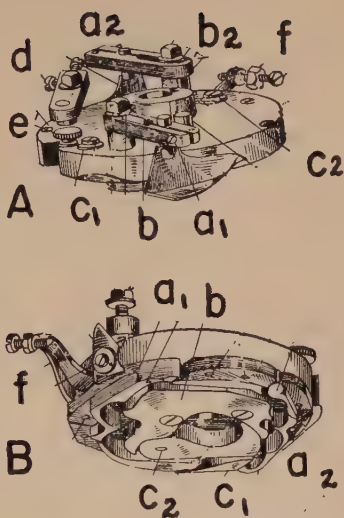


Fig. 9A and 9B—Dial cap.

The selvage hem or non-ravelling portion at the top of the hose is called a welt. The welt of a rib top, strictly speaking, refers to a small roll formed by retiring the dial needles and allowing the cylinder needles to knit alone, thus forming several courses of jersey fabric. Several of these, separated by intervening courses of plain rib and tuck, form the regular selvage welt. For the better grades of seamless and full-fashioned half-hose a French welt is employed. It consists of a tubular hem of jersey fabric which is perfectly flat and presents a very neat appearance.

The French Welt Machine

Fig. 10, as illustrated, is a development of the cylinder cam system of the Universal machine equipped to make French welt. The French welt machine invariably has two feeds for reasons which will be evident later. In Fig. 10, *A* and *B* indicate the clearing cam, *C* the guard cam and

D the stitch cam on the regular or loose course side; *J* indicates the clearing cam and *M* the casting-off or selvage welt cam for making the cylinder needles cast off their stitches and form clearing courses between tops. Cam *J* is attached to a stem *I* and ordinarily does not elevate the needles sufficiently high to clear, but when the inclined cam *L* is brought under stud *K*, the stem *I* and cam *J* are elevated sufficiently to allow the cylinder needle latches to clear. On being depressed by cam *M* they cast off their stitches, and make the dial needles hold their stitches.

Directly opposite stitch cam *D* is the second or French welt stitch cam *T* with clearing cam *O P*. Section *P* also is attached to a stem *Q* and may be lowered (by removing the supporting cam *S*) to the non-clearing or tuck level. The function of the various cams will be treated in a later paragraph. It is sufficient at present to understand their construction.

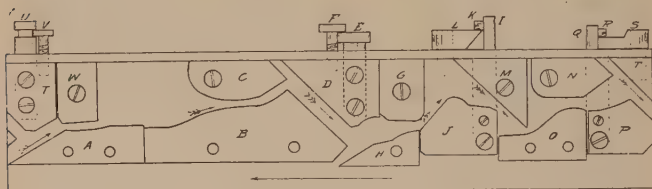


Fig. 10—Development of the cylinder cam ring.

The dial cam system with two views of the dial cap used on the French welt machine may be found in Fig. 9A and Fig. 9B. Yarn guides a^1 and a^2 are held by adjustable arms b and b^2 . The dial stitch cams are adjustable by means of screws c^1 and c^2 to shorten or lengthen the dial stitch. The cap is rotated by a driving arm attached to the thread guide driver d , as in Fig. 2. A thumb screw e , Fig. 9A, permits a section of the dial cam to be swung out, thus providing ready access to the dial and dial needles. A lever f controls the stitch cam on the French welt side and serves to force it in during the knitting of the French welt where a longer stitch is required. Fig. 9B shows the dial cams and the needle butt raceway; a^1 and a^2 represent the stitch cams, b

the guide cam, and c^1 the welt cam which swings on a pivot c^2 and may occupy one of three positions: first—when in its full outward position the dial needles are thrust out to the clearing position and regular knitting follows, second—it may be moved toward the center. This is the non-knitting or tucking position, and third it may be moved all the way in, retiring the dial needles with their stitches to the idle or welting position.

The changes which take place in the knitting head during the formation of a hosiery top with French welt are: (1) thrusting in the loose course device; (2) removing the loose course device; (3) moving the welt cam c^1 to the tuck position; (4) slackening the cylinder stitch on the regular or loose course side; (5) moving welt cam c^1 to welt position; (6) elevating cam j , Fig. 10, to the clearing or casting-off position; (7) lowering cam P , Fig. 10, to the tuck or non-clearing position; (8) slackening the dial stitch cam in Fig. 9B on the French welt side; (9) retarding the feed through the yarn guide on the French welt side; and (10) returning

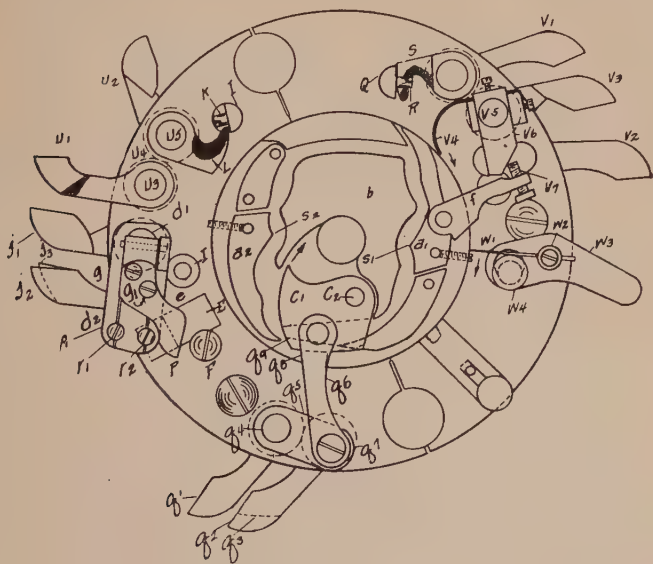


Fig. 11—Dial cam system and control levers.

made just distinct enough to be transferred easily. When lever j^1 is struck, the mechanism is removed.

The slack course mechanism has a third lever j^3 , shorter than j^2 , thereby effecting less movement of the device, sufficient only to bring screw r^2 upon the stitch cam post cap E , lengthening the cylinder stitch only slightly. This position is maintained during the knitting of the French welt. The cylinder stitch adjustment for the French welt therefore is screw r^2 . The slack course levers are shown in elevation at Fig. 12 as j^1 , j^2 and j^3 in the fourth, sixth and second levels, respectively.

The dial welt cam shown in its normal position at C , Fig. 11, may be swung inwardly on the pin C^2 by levers q^2 and q^3 . When lever q^2 is struck, the motion is transmitted through post q^4 , arm q^5 , link q^6 to the cam C^1 , swinging it toward the center of the dial. The needle butt raceway q^9 is therefore changed so that the dial needles are not forced outwardly but remain idle in the welt position. Striking lever q^1 returns cam C^1 to the knitting position. Striking the low portion of lever q^2 indicated at q^3 places the cam C^1 in the half-way or tucking position. The dial welt and tuck levers are shown in elevation as q^1 , q^2 and q^3 , Fig. 12, and occupy the fourth, third and second levels, respectively.

The casting-off cams for pressing off the cylinder stitches just previous to beginning the welt, shown as M , J , etc., Fig. 10, are operated by levers u^1 and u^2 , Fig. 11. When lever u^1 is struck, motion is transmitted through u^3 , u^4 and u^5 to L . The hook L is moved under the stud screw K , elevating the stem I and the attached clearing cam J , Fig. 10. This clears the cylinder needles, which, upon being lowered by cam M , press off their stitches. Lever u^2 returns the mechanism. The levers u^1 and u^2 shown in elevation at Fig. 12 occupy the fifth and first levels, respectively.

The French welt cams are controlled by three levers, v^1 , v^2 and v^3 , Fig. 11. When lever v^1 is struck the cam S is revolved from under stud R , allowing the stud Q with the clearing cam P , Fig. 10, to drop to the non-clearing position. The object in this series of movements is to cause the yarn at the French welt feed to be delivered to the dial needles

only. At the opposite feed the cylinder needles are knitting only, so that in effect two separate jersey fabrics are to be knitted at the same time on opposite feeds. Having lowered cam P , Fig. 10, to the tucking position by striking lever v^1 , Fig. 11, the yarn guide v^4 may now be moved backward so as to feed yarn to the dial needles only. This action must occur slightly later than the dropping of the clearing cam, since a few needles between v^4 and R have already cleared. By the time lever v^2 reaches the disc these needles have formed their stitches. The first tucking needle has reached the yarn guide so that it may be removed safely. The lever v^2 , following in the path of v^1 , causes post v^5 to revolve partly, moving the yarn guide in the direction of the arrow where it supplies yarn to the dial needles only. At the same time arm v^6 is brought under screw v^7 , forcing lever f to move the dial stitch cam a^1 inwardly, thus slackening the dial stitch for the French welt.

Pattern Mechanism and Stop Motions

The object of the pattern mechanism is to produce automatically at the proper time the changes described in the first two parts of this series. The pattern mechanism consists of a pattern wheel a , Fig. 13, with ratchet edge driven by a pawl b , set on the eccentric c , a sprocket wheel d carrying a timing chain e having starter links f . The sprocket is driven by the descending fabric which makes contact with a fabric wheel g . The fabric wheel is set loosely upon the shaft h and drives the gear i (likewise loose upon the shaft) by connecting rods j . Gear i drives the sprocket through gear k on the opposite end of the sprocket shaft.

The pattern wheel dwells during regular rib knitting, but is set in operation as follows to form the slack course and the welt: The last rack of the pattern wheel brought a lug l under the starting lever pawl m , raising it so as to elevate the racking pawl b and let it escape the ratchet. The chain is moved slowly around by the descending fabric until a link f comes under the starting lever n letting pawl m drop off lug l and allow the pawl b to move the pattern wheel.

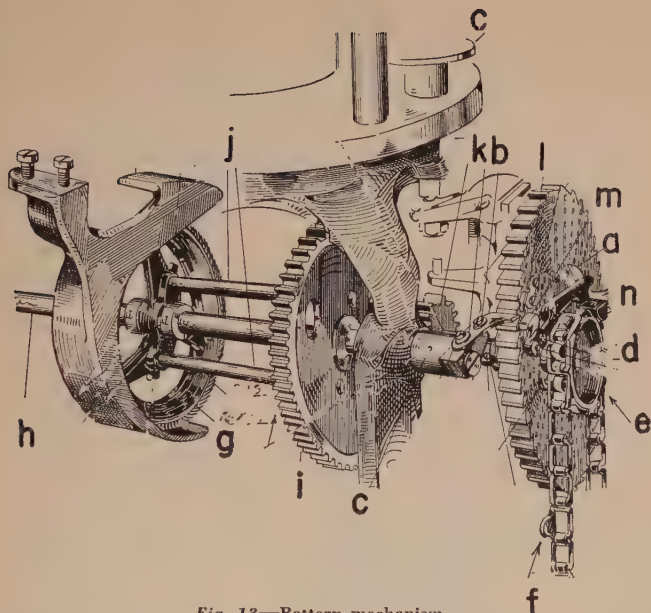


Fig. 13—Pattern mechanism.

When a complete revolution has been made, the lug *l* again elevates the pawl *b* and stops the pattern wheel.

The pattern disc *o*, Fig. 14, is raised and lowered by pins set in the pattern wheel which act on the pattern disc arm *p*. Fig. 14 is a view of the pattern wheel bracket. The pattern disc *o* mounted on the upright shaft *t* may be set to, or from, the cylinder cam block by loosening the screw *v* and partly revolving the eccentric bushing *u*. The drop of the disc from high to low position is made positive by a spring *w*. Connection is made between the arm *p* and the upright shaft *t* by a latch *r* which fits into a groove at its lower extremity.

Fig. 15 is a view of the pattern wheel set up for the French welt machine. The pins are arranged in six concentric circles corresponding to the six planes, Fig. 12, in which the control levers are set. In addition, the large screws operate the belt shifting apparatus. Series No. 1 holds the belt on the slow-speed pulley, Series No. 2 keeps the belt on the high-speed pulley.

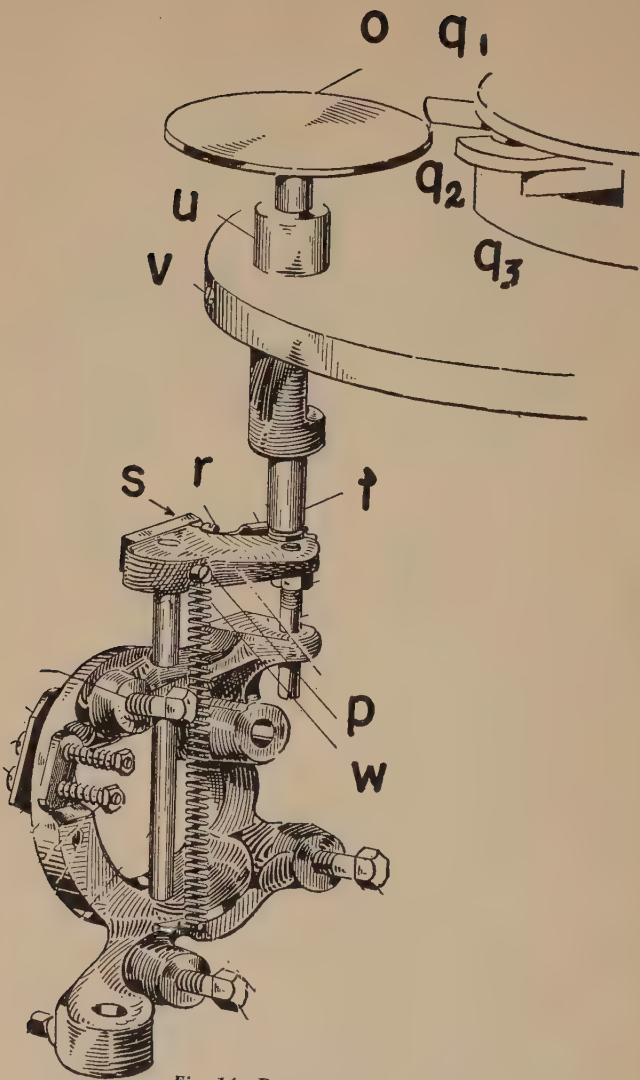


Fig. 14—Pattern wheel bracket.

As the pattern wheel turns, the different pins function as follows: 1 and 2, slack course is formed; 3 through 8, reg-



Fig. 15—Pattern wheel (French welt).

ular rib fabric (ravelling waste); 9, dial needles tuck, cylinder stitch is lengthened on French welt side; 10 and 11, dial needles idle (welt); 12, cylinder needles press off (clearing course); 13, cast-off returned to normal, cylinder needles tuck, dial stitch is lengthened and yarn guide is thrown back on French welt side; 14 through 20, French welt (number of pins optional); 21, dial stitch clears, cylinder and dial stitches are tightened, yarn guide is returned to normal position and cylinder needles clear on French welt side; 22 through 42, regular rib.

Fabric Take-up

A ribber, knitting as it does without sinkers for holding the fabric down on the needles, is supplied with a device for drawing off the fabric, under tension, as it is formed. The construction of the mechanism employed on the Uni-

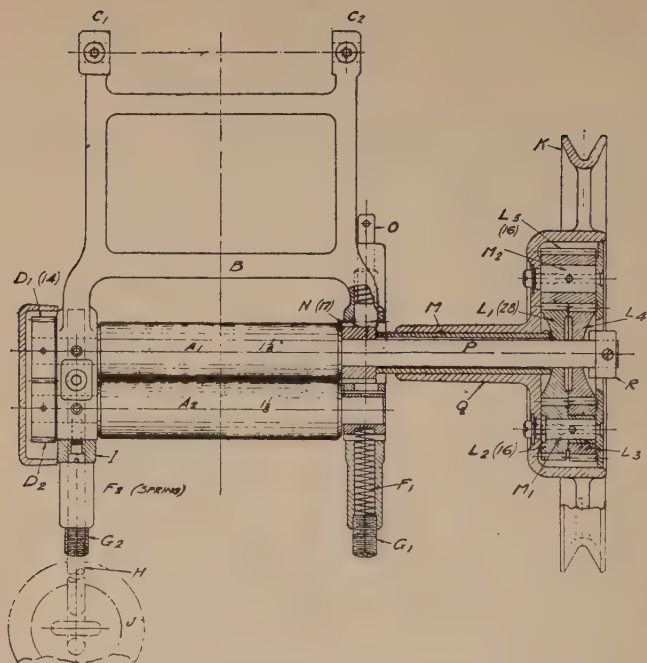


Fig. 16—Fabric take-up

versal ribber for this purpose is shown at Fig. 16. It consists of a pair of fluted rolls A^1 and A^2 set in a frame B which is pivoted at C^1 and C^2 . The fluted rolls are geared together by gears D^1 and D^2 . The fabric passing between the rolls is held under pressure of the two coil springs F^1 and F^2 . The tension of the spring and the amount of pressure exerted upon the rolls may be regulated by adjusting screws G^1 and G^2 .

The entire frame is free to swing downward on the pivots C^1 and C^2 , but normally is supported by the fabric held between the fluted rolls. In cases where this pull is too small to produce good knitting, a weight J may be added. The pull exerted by the weight is regulated by extending or withdrawing the lever in the arm I . In cases where the weight of the carriage is too great for the fabric, the weight

J and lever *H* may be removed, set in the frame at *C*¹ and the weight used to support the carriage partly.

The rolls are driven by a sheave pulley *K* connected by a belt with a smaller one on the drive shaft *e* Fig. 7. As the descending fabrics allows the carriage *B*, Fig. 16, with pulley *K* to be lowered, tension is placed on the driving band and the rolls *A*¹ and *A*² are revolved. In so doing they climb the fabric and elevate the carriage and sheave pulley *K* until the driving band is slack and does not drive it. The take-up therefore ceases until more fabric is delivered when the driving band becomes taut and the operation is repeated.

In order to give the take-up rolls *A*¹ and *A*² as smooth an action as possible, to keep uniform tension of the knitting, there is a very small speed ratio between the driving surfaces of pulley *K* and the drawing-off surface of *A*¹ and *A*². The speed of the sheave pulley *K* is reduced by a system of planetary gears *L*¹, *L*², *L*³, *L*⁴ and *L*⁵. Gear *L*¹ is held stationary by a sleeve *M* attached to gear *N*, which is locked by the ratchet pin *O*. Gear *L*⁴ is attached to the shaft *P* by a collar *R* and drives the shaft as follows: As the pulley *K* revolves once, the planetary gear *L*² of 16 teeth revolves once around the stationary sun gear *L*¹ of 28 teeth. This rotates gear *L*² on the stud *M*, $28/16 = 1.75$ times. Gear *L*³ attached to it also is rotated 1.75 turns or $1.75 \times 16 = 28$ teeth. This is one tooth more than the gear *L*⁴ contains. Therefore the gear *L*⁴ is moved one tooth backwards, driving the shaft *P* and the roll *A*¹ $1/27$ th of a revolution in the opposite direction for each revolution of the pulley *K*. This low speed ratio between the pulley *K* and the roll *A*¹, 27 to 1, insures a gradual, uniform take-up and the intermittent motion is almost eliminated.

In an effective device for speed control the belt is shifted from slow to high speed and vice versa by means of a belt shifting device, Fig. 17. The device includes a belt guide *a*, a brake lever *b*, brake lever stud *c*, shifter rod *d*, shifter rod spring *e*, shifter handle holder *f*, shifter lever *m* pivoted at *b* in the pattern wheel bracket. Attached to the lever *m* are two cams between which the large pins in the pattern

wheel, Fig. 15, pass. Series No. 1, acting on cam *j*, forces the arm *m* to the right. This moves the entire device to the right and guides the belt on to the slow-speed pulley. When series No. 2, Fig. 15, reaches the cams, the device is reversed and the belt is returned to the high-speed pulley.

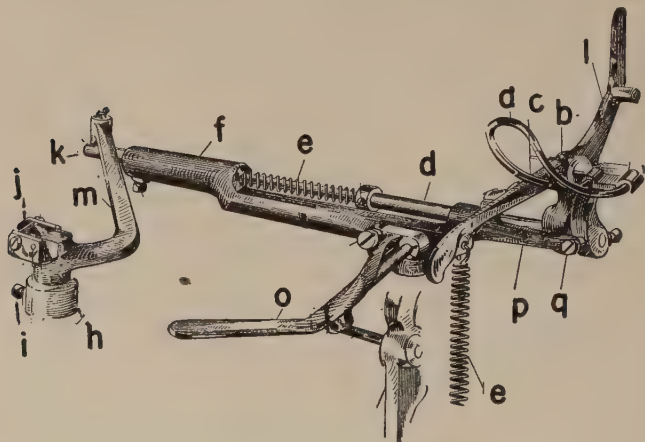


Fig. 17—Speed control mechanism.

Stop Motion

The application of stop motion devices for arresting the motion of the machine, when bad work is being made or is likely to be made, increases the number of machines which one person can operate and greatly reduces the possibility of damage to the machine. Practically all stop motions for hosiery machines operate mechanically. In some instances an electrical stop motion has been applied successfully. The Universal ribber is equipped with either the stationary or revolving type of stop motion. The stationary stop motion is applied to single-feed machines, while the revolving stop motion is applied to machines having two feeds or two-color striping attachments. The principle of operation is the same in both cases. The motion of the machine is arrested when any one of the following incidents occurs: cone or bobbin is exhausted; thread hitches on cone or bobbin; slub appears in the yarn; fabric is pressed off; and yarn loads the

needles. The stationary stop motion illustrated at Fig. 18 functions as follows:

When the cone is exhausted, the thread which previously has been passing between the thread plate *a* and the falling finger *b* no longer supports the falling finger and allows it to drop. Through a trigger mechanism in the head, the rod *d* is revolved partly. This removes the support from

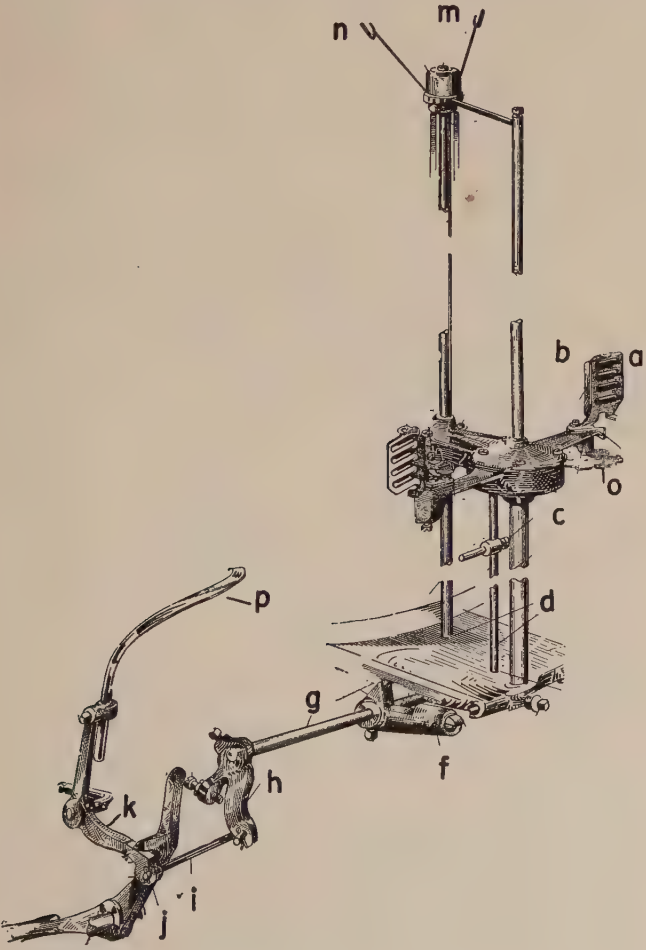


Fig. 18—Stationary stop motion.

under the trigger *f*, and allows it to drop. The rod *g*, impelled by a coil spring under the stop motion bracket, is revolved partly, lowering the latch arm *k* through lever *h* and connecting link *i*. This releases the brake handle *j* which previously has been held in the notch at *l*. The brake lever stops the machine as follows: Referring to Fig. 17, the brake lever *k*, on being released under force from the spring *e* strikes the stopping link *p*, which being pivoted at *q* releases the shipper handle *o*, allowing the spring *e* to shift the belt to the loose pulley; the brake *d*, Fig. 6, is applied by the brake stud *c*; the brake lever being pivoted on *c*, partly revolves it when released by the stop motion. This expands the brake hand and stops the machine.

When the thread catches on the cone or, for any reason, is prevented from unwinding freely, the resulting tension on the thread draws down one of the levers *m* and *n*, Fig. 18, which, by means of connecting with the trigger mechanism in *c*, trips the stop motion operating as previously described.

A thread disc *o* contains holes of various sizes to suit the number or quality of the yarn being used. The thread is drawn through a hole of such diameter that large knots or slubs will be arrested. The tension resulting stops the machine as described in the previous paragraph. The danger of the thread breaking at the feed and causing needles to press off while the machine is stopping is overcome by allowing the levers *m* and *n* a full sweep. When the levers are lowered sufficiently, the thread is released entirely by the open hook.

The fabric, upon being released by the needles, allows the drawing-off device to drop. A chain connects this device with the stop motion. The tension applied by the drop of the drawing-off device trips the stop motion and arrests the machine.

A clacker point, *w*¹, Fig. 11, is set so as to revolve very close to the needle hooks at the junction of the cylinder and dial. Any obstruction such as yarn loading upon the needles catches on the point and in so doing moves it backward in the direction of the arrow. The clacker arm *w*³ which

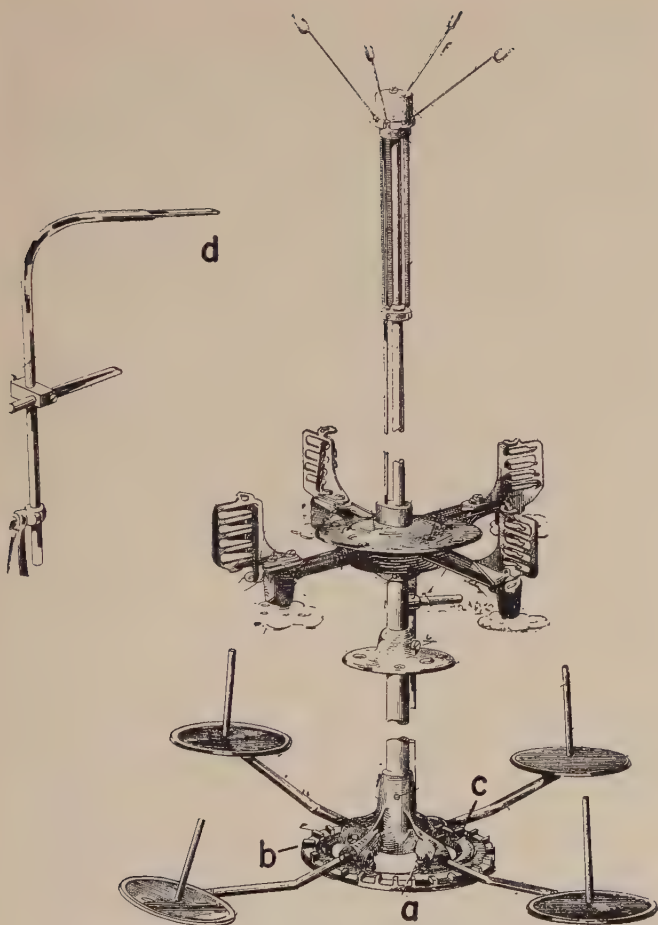


Fig. 19—Revolving stop motion.

previously has been depressed and held by a notch in the post w^4 , is freed and raised by a coil spring. At this elevation the clacker arm strikes the lever p , Fig. 18, and trips the stop motion.

The revolving stop motion, shown at Fig. 19, operates in much the same manner as the stationary type. The device is attached to the top of the head by a special bracket. Lying

loosely upon the top of the bracket is a stationary ring *a*, with lugs *b*. When the stop motion is tripped from above by any means previously described, the latch *c* is projected between the lugs of the ring *a*, bringing the ring into motion also. In doing this the knock-off lever *d*, which has been in contact with ring *a*, is actuated, tripping the stop motion through the arm *k*, Fig. 18.

The stop motion shown in Fig. 19 permits the use of four threads. It is applied to two-feed machines equipped with two-color stripers, or to machines for plating one thread over another. In this manner a thread of a good quality may be used to cover a thread of poor quality. Plating may not be accomplished on single-feed machines equipped with stationary stop motions, due to the twisting of the threads. The use of a central bobbin table overcomes this difficulty. It provides a revolving support for one cone. The one thread supplied by the stop motion may be delivered to the needles independently of the other. This attachment also is used frequently with a two-color striper on single-feed machines.

Stitch Alteration and Use of Color

Knit fabrics may be ornamented by two general methods—using color to form a variety of vertical and horizontal stripes, checks, blocks, diamonds and figures, or altering the stitch in various places according to some preconceived design.

Color may be inserted as ornamentation in both horizontal and vertical stripes. Attachments are made for producing horizontal stripes in two colors, requiring a simple interchanging of two yarn feeding fingers. When more than two colors are required, a four-color attachment is supplied. This style of striper has a single yarn guide. The threads of different colors are inserted by a knotting and selecting mechanism which ties the thread to be substituted to the one being fed. The same device has been used to change as many as five and six colors. In addition to making possible a wider range of color combinations, the four-color attachment has another advantage over the two-color unit.

The two-color attachment splices the yarns at the feed by introducing and removing two yarn feeding fingers. Should the change not be effected correctly, a press-off occurs. The knotting device on the four-color attachment is placed at the rear of the machine. The thread, after passing the knotter, is led through the stop motion and should the knotter fail to operate successfully, the machine is stopped without a press-off.

Three devices, known as the drop stitch, the tucking and the tuck stitch attachments, are employed to alter the stitch. If, in using the drop stitch attachment, a needle fails to receive yarn at the feed or after receiving the loop is made to cast it off before the hook receives another loop, the stitch is dropped. A needle knitting in this manner produces an open stripe or drop stitch wale in the fabric. This principle is a very old method of ornamenting knitted fabrics. It probably was first produced by removing needles from the needle cylinder or bed, at intervals, so as to produce the pattern desired. In making infants' fancy tops, the drop stitch stripes usually are made only in the lower section, the cuff being made of plain rib fabric. This requires a special attachment for producing the drop stitches at the proper places.

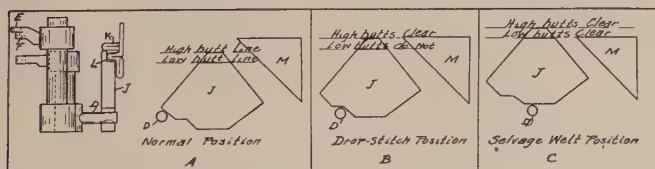


Fig. 20—Drop stitch attachment.

The drop stitch is produced by placing special high-butt needles in the cylinder at points where drop stitches are desired. By a special arrangement of the selvage welt cam the high-butt needles may be raised to the clear level independently of the regular needles and made to shed their stitches. The construction of the device is shown at Fig. 20. The selvage welt cam is cut away partly on top to give separate elevations to the high and low-butt needles K and L,

respectively. It is obvious that in raising the cam *J* the high-butt needle *K* will clear before the low-butt needle *L*. The cam *J* may be operated at three elevations, as shown at steps *A*, *B* and *C*. The normal position is *A*, in which the cam is inactive. A special operating lever with faces *E* and *F* is substituted for the regular selvage welt lever. Striking the face *F* moves the pin *D* under the cam, bringing it to position *B*, which is the drop stitch level. The high-butt needles, riding over the high point of the cam, clear the stitch and shed or drop their stitches when depressed by *M*. The low-butt needles, passing through the gap, do not clear. Striking the lever at *E* brings pin *D* under the cam. In this position all needles clear and cast off their stitches. Before beginning the drop stitches in the pattern, one or more tuck courses are inserted to prevent the dropped stitches from running back. Upon ending the drop stitches a similar anti-runback course is made.

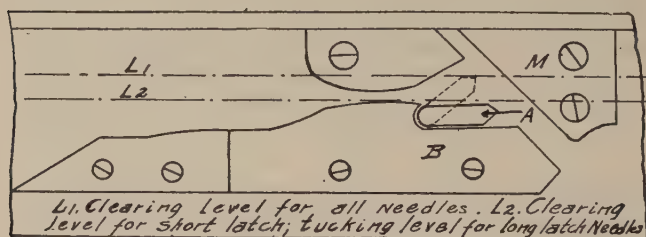


Fig. 21—Cylinder cams, tucking attachment.

The tucking attachment is a device applied to the cylinder clearing cam. It operates certain cylinder needles to tuck and thus produce tucked wales or stripes and lace effects. A special long latch needle is placed in the cylinder where the tucking is to appear in the fabric. These needles require a greater lift for clearing than the regular short latch needles. Ordinarily, the elevation of the clearing cam is sufficient to clear all needles. Tucking is effected through the use of a swinging section in the cylinder clearing cam shown at Fig. 21. The high portion of the cam is cut away and the tucking cam *A* inserted. Cam *A* may be raised so as to lift all nee-

dles to the clearing point, or may be lowered so as to clear only the short latch needles. The long latch needles failing to clear produce tucks in the fabric.

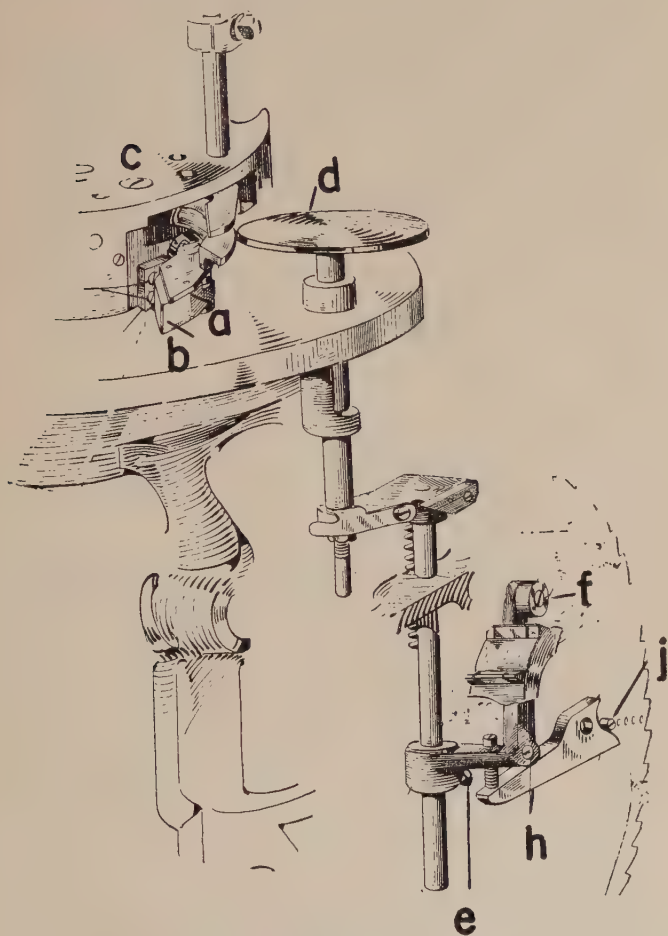


Fig. 22—Cylinder tucking attachment.

This device is operated on the end of a swivel and is controlled by a special set of levers shown at Fig. 22, *a* and *b*. The levers make contact with the tucking cam dowel *c*.

Lever *a* strikes the dowel at the top and elevates the tucking cam to the clearing position. Lever *b* strikes the dowel at the bottom and lowers the tucking cam to cause the long latch needles to tuck.

The pattern wheel is set up so as to allow the pattern disc *d* to drop to its lowest point, where tucking is to be begun. This brings the disc under control of a special bracket *e*. Roller *f* operates by the side of the striper chain. Special links attached to the side of the chain raise and lower the pattern disc to produce the tuck stitches. The link causes the stitch to clear, the absence of a link causes the tuck.

When the part of the pattern containing tucked stitches is finished, the pattern disc, which has been lowered greatly from its normal position, must be returned. The elevation for the following change, which usually will be the slack course, is the outside row of pins. This rise, which ordinarily is too great to be effected with one rack of the pattern wheel, is accomplished through a lever *b* pivoted on the pattern wheel bracket. The movement of the pattern wheel brings a pin *j* in contact with its heel. This elevates the pattern dial in one rack.

Tuck stitches may be made on alternate courses to form vertical stripes, or may be inserted at intervals to give broken up and lace effects. When used with color, a wide range of combinations and designs is possible.

The tuck sitch is a method of ornamentation in hosiery knit with both the jersey and rib stitches. It is produced in the former by making the needles tuck for one course at intervals in knitting. Machines equipped for making tuck stitches in jersey usually have long latch needles spaced regularly in the cylinder or alternately in groups, according to whether an all-over effect or a stripe is to be made. Tucking is effected by lowering the clearing cam, which in footers is the right-hand stitch cam, for one revolution. The drop is sufficient to bring the long latch needles to the tuck position. This produces a horizontal line which may be combined with the drop stitch effect to form checks.

In ribbed work a horizontal line may be produced by the formation of a small welt. This is produced in the

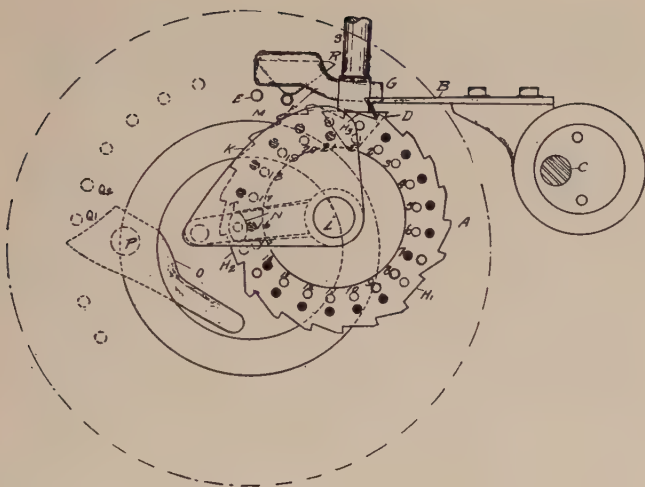


Fig. 23—Tuck stitch attachment.

customary way by retiring the dial needles for one or more revolutions. Where any great number of these welts is to be made in a pattern, an attachment is required to control the welt pin or pattern disc. Fig. 23 is a view of a tuck attachment used on a rib machine. It consists of an auxiliary pattern wheel *A*, which is capable of lowering and raising the welt pin to the welt and clearing positions, respectively. The extra pattern wheel is operated from a pawl *B*, which is reciprocated by an eccentric on the drive shaft *C*. An extra cam *D*, similar to the regular pattern wheel cam *R*, is attached to the supporting arm *F* at such a height as to support the welt pin *S*. Pins placed in the outside row of holes support the pattern disc at the fourth or regular rib elevation. Pins in the second row of holes support the pattern disc at the third or welt elevation, Fig. 12, where it strikes the welt lever q^2 . Provision is made for stopping the mechanism as follows: a quadrant-shaped buffer cam *K* is pivoted at *L*; ordinarily the cam is supported by a lever *O* elevated by a row of pins such as Q^1 and Q^2 in the pattern wheel; in this position it raises the pawl *B* slightly and allows it to pass over a short tooth such as H^1 , H^2 and H^3 . The pattern

wheel then remains inactive until the main pattern wheel is moved around to a point where no pins are placed to support the lever O ; it then drops down as shown, allowing the quadrant K to drop and expose the short tooth H^3 . The pawl then sets the attachment in motion again.

The pattern wheel is pinned with one screw in the inner circle and five in the outside circle. This will produce a pattern containing one welt course and five plain courses. Three repeats of the pattern are made in the wheel. It will be noticed that the holes under the short teeth H^1 , H^2 and H^3 are left blank. This arrangement is made because the short teeth come to rest under the cam D . During the time the auxiliary pattern wheel is dwelling, the main pattern wheel must drop the welt pin arm G to the lowest position for forming the welt.

Chapter II. Rib Knitting With Extra Embroidery Yarn For Ornamentation

THE demand for novelties has been felt not only in the manufacture of men's hosiery but in the production of infants' lines as well. The tops of the infants' hose always are exposed to view and therefore furnish a desirable place for the introduction of ornamental work. The knitting of fancy patterns first was undertaken in plain or jersey fabrics; its use in rib fabrics came later due to the more complicated mechanisms in the rib machine. The first fancy tops were for this reason formed with the plain fabric as a base.

As the market for novelties developed, it was seen that a rib top with ornamental work would be a more desirable product because of the more elastic qualities of the rib fabric. With this objective in view, the Fidelity Multi-Design was built to make fancy tops with "true ribbed" fabric as a base. The machine features a rib knitting unit consisting of a cylinder and a dial, a plating unit consisting of fingers controlling individual threads so as to introduce them to separate needles through a controlling cam, a pattern mechanism governing the horizontal striping, and a yarn selecting, changing and knotting mechanism controlled by the pattern chain.

Fig. 24 is a sectional view of the machine head showing the cylinder *A*, the dial *B*, and the operating cams. The cylinder and dial are equipped with needles which function as in regular rib knitting. They are controlled by the cams to form welts, loose courses, etc., in the same manner as the regular rib machine.

Wrap Attachment

Situated just over the needle cylinder *A* in Fig. 24 is the plating mechanism. It consists of a special cylinder *C* containing slots corresponding in number to those in the needle cylinder. Into these slots are placed special plating fingers *D* which supply the plating thread *E* to the corresponding

needle. The thread *E* is fed from a small bobbin *F* contained in a small glass tube *G*. The creel may contain a separate bobbin for each needle in the cylinder if the design is to cover the entire fabric and each bobbin may be



The Fidelity Machine Co. Style S-13 ten-step Multi-Design ribber.

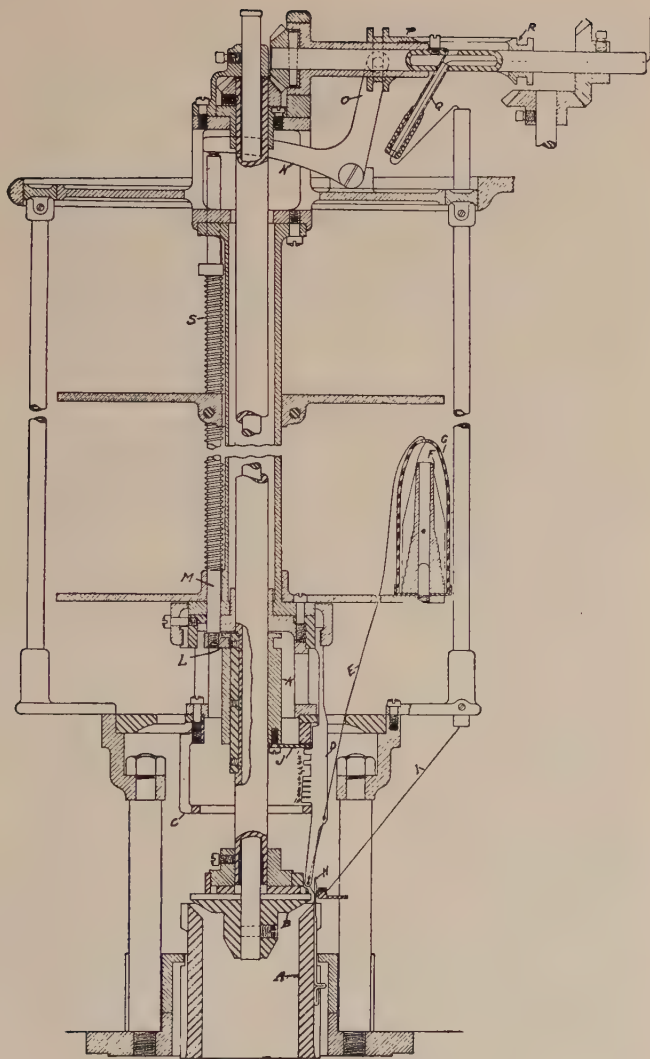


Fig. 24—Sectional view of machine head.

of a different color of yarn. Therefore, it is possible to make each wale in the fabric a separate color.

Normally the thread *E* is retained in the inward position

as shown in Fig. 24. It is, therefore, not received by the hook of the needle *H* and knitted into the fabric but passes between the cylinder and dial and floats upon the inside of the tubular fabric. At certain times the finger is forced outward so as to pass beyond the needle line. The tip of the finger *D* is so shaped as to pass outward on one side of the needle *H* and return on the other side. In so doing it coils the thread *E* once around the needle. The result is that the needle forms a chain or crochet stitch from the thread. This action takes place considerably in advance of the point where the stitch is drawn. The thread *I* which forms the ground fabric occupies the outside of the needle hook and is therefore covered by the plating thread *E* in the wale formed by the needle *H*.

The order in which the finger *D* is operated to produce plating is determined by the position of the operating butts 1-10 in Fig. 24. These are acted upon by a cam *J* attached to the sleeve *K* which may be operated in the idle position as shown or in ten lower planes corresponding to the butts 1-10 of the finger *D*. The cam *J* makes one revolution for each course of knitting and in so doing forces outward all fingers having butts in its plane of revolution.

The cam *J*, Fig. 24, is raised and lowered with the sleeve *K*, lug *L*, and rod *M* which is depressed by means of a bell crank lever *N* and *O*, itself actuated from the pattern chain through the sleeve *R* and *P*. The sleeve *K* is lifted by a coil spring *S* when pressure is released at *N*.

Striping Attachment

An important feature of the Multi-Design machine is the five-color striping attachment which permits the use of as many as five colors in the basic rib fabric. Yarn changes in the basic fabric are made to form horizontal stripes which add greatly to the figured part of the top produced by the plating unit.

The device consists of a yarn selecting and knot tying mechanism whereby the five threads are interchanged in any order desired by tying one thread to another upon withdrawing that thread from the needles. This operation is

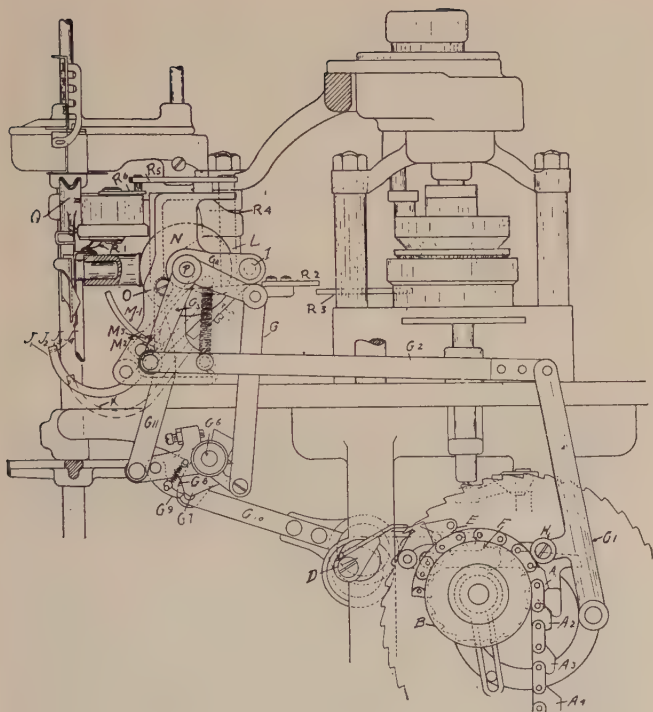


Fig. 25—Four-color striping device of Multi-Design machine.

accomplished without arresting the motion of the machine. The knot tying feature eliminates the older method of striping by splicing or doubling the threads at the point of change. The action is therefore performed with more certainty. The yarn change is made at a point considerably removed from the needles. This feature permits the use of a stop motion between the change mechanism and the needles and should the function of yarn change fail, the machine is stopped without a press-off, whereas any failure on the part of the strippers which splice the thread results in the fabric being pressed from the machine.

Fig. 25 is a view of a machine equipped with the striping device. The selecting unit comprises a pattern chain with striping links A^1 , A^2 , etc., of five distinct elevations.

The chain is revolved upon a sprocket *B* carried by the shaft *C* which is operated from the driving shaft *D* through the pawl *E* and the ratchet *F*. The stripper links *A*¹, *A*², etc., in the revolving chain, operate the lever *G*¹ and control the selecting mechanism through lever *G*², as follows: attached to the arm *G*³ is an interior cam controlling a sliding arm *M*² through the pin *M*³ which operates in the cam race; in this manner the sliding arm *M*², carrying with it the operating cam *L*, is made to assume a position directly over any one of the fingers *J*¹, *J*², etc., according to the position of arm *G*³.

When the roller *H*, Fig. 25, is in contact with the plain links, the sliding lever *M*² and operating cam are located



Fig. 26a—Typical hosiery tops from the Multi-Design ribber.

directly over the yarn finger J^1 . When link A^1 is brought under roller H the operating cam acts on lever J^1 . The movement given arm G^2 is communicated also through levers G^3 , G^4 and G^5 to partly revolve a small shaft G^6 upon which is placed a buffer cam G^7 . Normally this cam covers a driving block G^8 and prevents it from engaging the pawl G^9 . The movement of the buffer cam G^7 exposes the driving block G^8 which is being reciprocated from an eccentric upon the shaft D through arm G^{10} . The pawl G^9 thus is struck by the driving member and the arm G^{11} moved suddenly upward. Being attached to the bevel gear N at O , it partly rotates the gear and with it the shaft P and cam L . The cam L presses downward the finger J^1 to the position K bringing the thread in contact with the yarn mechanism Q which collects the old and the new threads and presents them to the knotter.

The knotter is operated to tie the thread from the arm R^2 which is lowered into the path of the operating cam R^3 by the control link A^1 , etc. The movement given the

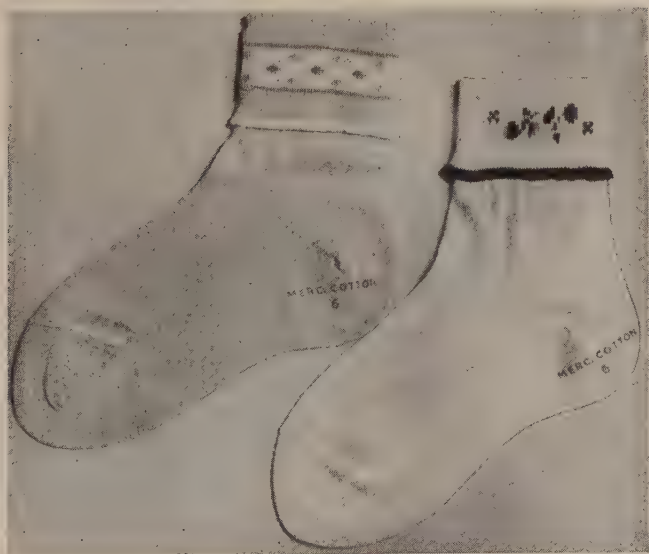


Fig. 26b—Transfer style children's hose with fancy tops ornamented with extra yarn.

arm R^2 is transmitted to the knoter through shaft R^4 , link R^5 and lever R^6 .

As stated in a preceeding paragraph, designs for the Multi-Design machine are made by combining horizontal stripes in two, three, four or five colors with stripes or figured effects in as many colors as are desired, with 90 as a limit. Later models of the 25/52 class are capable of making patterns in 25 steps, with as many as 120 colors in the vertical pattern. Fig. 26a is a reproduction showing some infants' fancy hosiery tops, illustrating a few of the



Fig. 26c—Transfer style crew sock with fancy top made on the rack welt ribber with Multi-Design wrap feature for vertical stripes and five-color knot tyer for horizontal striping.

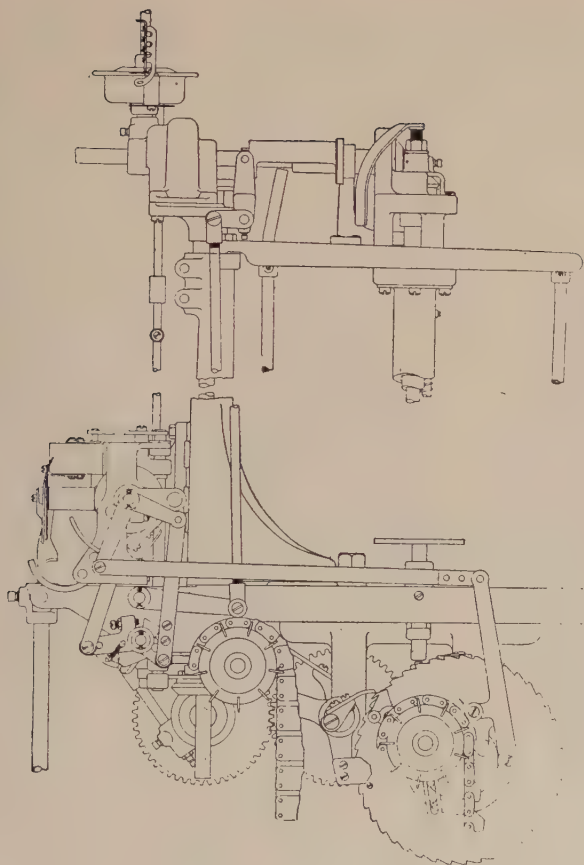


Fig. 27—Side elevation of 16-step Multi-Design ribber.

pattern and color combinations which are possible in products of the Multi-Design machine. Fig. 26b shows two children's socks made on transfer machines, using tops from the Multi-Design machine.

The designing unit is the plating finger *D*, Fig. 24, shown also at Fig. 28. The finger is made of flexible steel and normally has ten projecting butts as indicated. The fingers are forced outward to form the pattern by an operating cam which

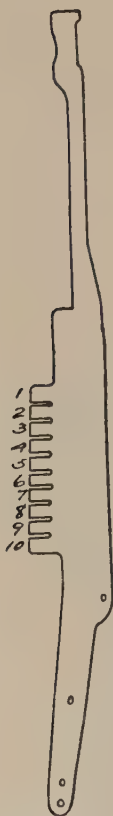


Fig. 28—Plating finger.

may be rotated at an elevation corresponding to any one of the ten butts. Some of the butts may be broken away so as to cause the plating finger to remain inactive when the operating cam traverses at that level. The plating is thus interrupted at the corresponding point and when this follows some regular order, a design is produced.

Fig. 29a is a design for the figured portion of a typical pattern for the machine. The design, shown in two repeats horizontally, covers an area of 16 wales and 40 courses. Fig. 29b is the butt arrangement or plan for setting up the machine to produce the design shown at Fig. 29a. It is obtained by combining all the courses from the design, which are figured differently. It will be seen that only seven of the ten butts will be required to make this design. Each vertical row of squares represents the order in which the butts are removed for one plating finger. The two on the extreme right remain intact. The third has the top butt removed. The fourth has the first and second removed and so on. The chain which governs the operating cam will be constructed as follows:

7 links	Number 0	2 links	Number 6
2 "	" 1	2 "	" 5
2 "	" 2	2 "	" 4
2 "	" 3	2 "	" 3
2 "	" 4	2 "	" 2
2 "	" 5	2 "	" 1
2 "	" 6	6 "	" 0
3 "	" 7		

The number of wales on which the design repeats must be a factor of the number of needles in the cylinder. The

design shown in Fig. 29a repeats on 16 wales and is suitable for a machine having 80, 96, etc., needles in the machine cylinder. Each wale of the design may be made of a different color if desired. The order of coloring in the second repeat may be the same or entirely different for the foundation fabric.

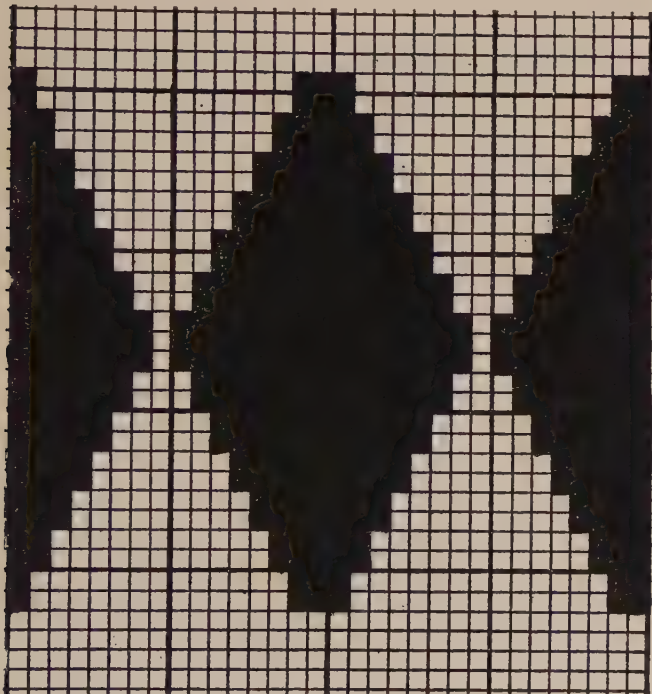


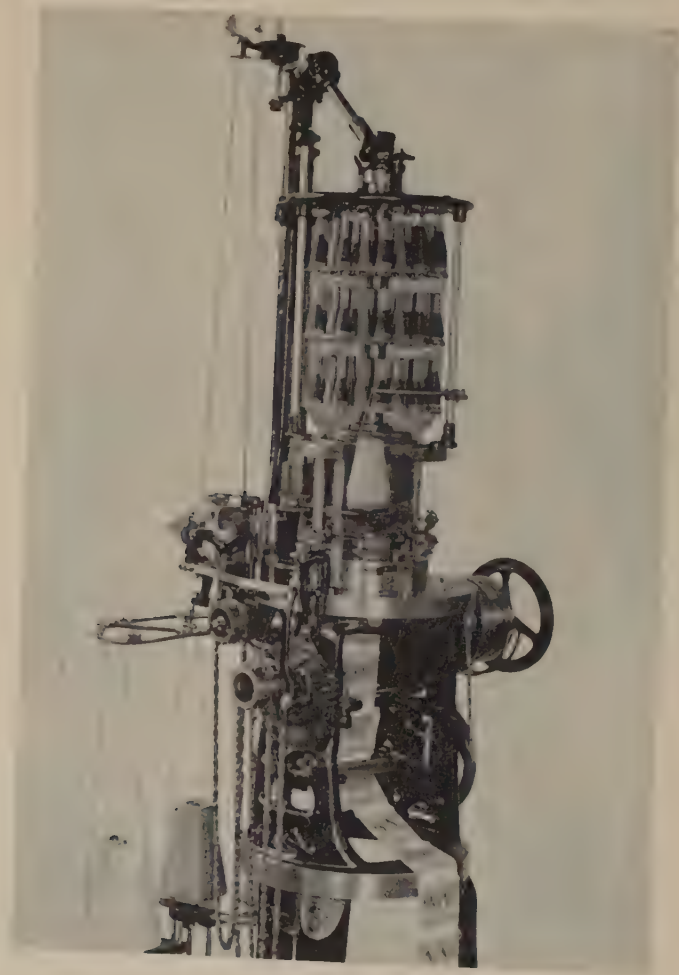
Fig. 29a—Design for figured portion of a typical pattern for the Multi-Design machine.



Fig. 29b—Butt arrangement or plan for setting up the machine to produce design shown at *Fig. 29a*.

The 25/52-Step Machine

The 25/52-step machine produces a far greater variety and intricacy of plating designs than the ten-step machine in that it gives $2\frac{1}{2}$ times the number of operating butts over each thread-wrapping finger; therefore, a correspond-



Style S-13-PE-25/52-step Multi-Design machine.

ingly greater range of pattern possibilities. It allows the same use of 120 vertical and five horizontal colors.

An additional advantage is that patterns may be changed without re-threading the fingers. This is because wrap fingers without butts are used, and these stay in the machine. The butts are carried by finger operators placed above the wrap fingers in the head of the machine, with the butts facing outward.

The finger operators are selected for action by the contact of a cam mechanism, which, in turn, is actuated by projecting pattern lugs on a pattern drum located outside the ring of finger operators. This drum is made up of flat metal rings, between which are spaces for holding the pattern lugs. By a simple arrangement of lugs on the drum in steps, one lug serves for all the plating stitches in a full course. The pattern drum advances one step with each revolution of the machine, bringing the lug for the next course in contact with the cam which strikes the butts on the finger operators rotating in its path. As each butt is struck and pressed inward, the wrap finger below it moves outward, passing on the right-hand side of the needle and returning on the left-hand side to its neutral position, thus forming the wrap stitch around the needle. The movement of the pattern drum is controlled by a pattern chain, made up of high links and low links. The high links move the drum step by step in the progression of the pattern, each high link advancing the drum one step. The low links are used to make as many stitches for the wrapped pattern as desired with the drum in any fixed position.

The design is first worked out on cross section paper, using any number of blocks needed up to 25 vertically. Each square represents a stitch. Those filled-in are the plated stitches; those left blank, the basic stitches not to be plated.

Starting from the left-hand side of the charted design, take one of the finger operators for each vertical row of squares, and counting from bottom to top, knock out the butts corresponding to the blank squares, or stitches not to be plated. Group the finger operators to form the design. Then, insert pattern lugs between the leaves of the pattern

drum in accordance with charted design. Assemble the pattern chain likewise. Place the finger operators in the machine as grouped, and after seeing that the wrap fingers are threaded with the desired colors, the machine is ready to start.

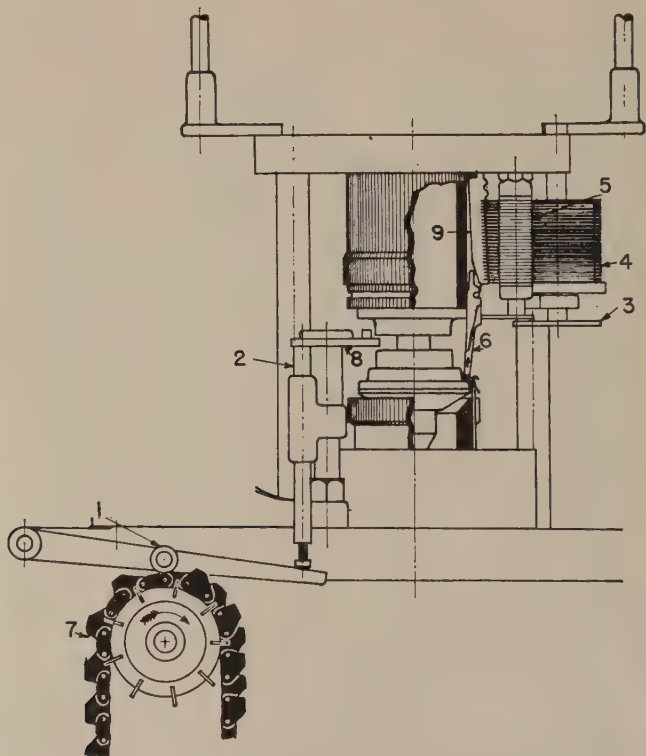


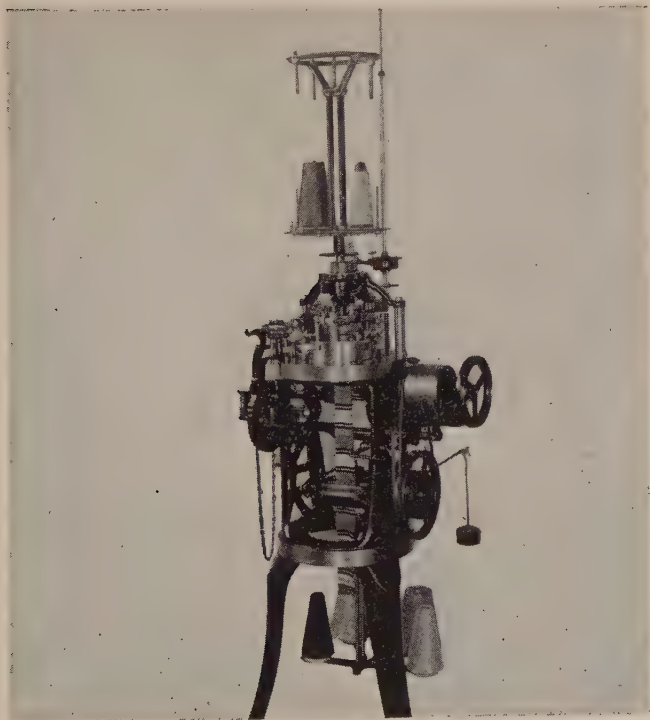
Fig. 30—Diagram of the head of the 25-step machine showing the wrap finger in idle position.

Fig. 30 is a view of the head of the 25-step machine showing the principal elements which produce the wrap pattern. The roller 1 rides on the pattern chain which has rise links spaced at predetermined intervals. The rise links elevate the pattern drum bob pin 2 and brings the bob into the path of the star wheel 3 located beneath the pattern drum 4. This causes the drum to be advanced one step.

The pattern drum is provided with lugs which operate butt selectors. These in turn strike the desired butts on the finger operators 9 to force them inward. This inward movement of the operators forces out the wrap fingers to place the extra yarn on the needles. The advance of the pattern drum by the bob pin through the pattern chain movement causes new lugs to come into position to operate other butt selectors to develop the pattern.

The Rack Welt Rib Machine

The popularity of the so-called crew sock led to the development of the rack welt rib machine. This machine is a rib machine constructed with cams for knitting the 2 x 2

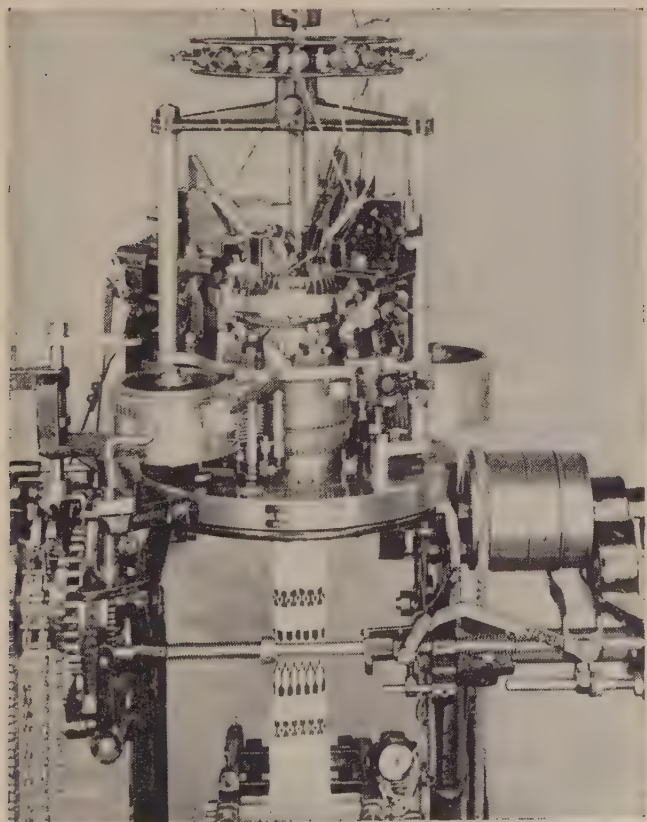


Style S-12-PE Fidelity single-feed rack welt rib machine.

rib, which is a characteristic of the top of the crew sock. The term *rack welt* indicates that for the welt portion of the top, the dial is racked one needle space in relation to the cylinder to bring the needles into a 1-and-1 disposition instead of the 2-and-2 arrangement. The welt so formed is greatly improved over that obtained by knitting in a 2-and-2 position. The latter would cause the welt to be notched and irregular. The crew sock is frequently ornamented with color and may be knit ingrain and the foot portions made from the same color and quality of yarn. The color in the top is obtained by use of the five-color knot tying attachment which is under the control of a pattern chain. By varying the links in the pattern chain it is possible to knit patterns similar to the ones appearing in the hosiery tops shown in Fig. 26c. The vertical wrap stripes in these tops was obtained by applying the multi-design principle to the rack welt rib machine.

Chapter III. Multiple-Feed Knitting With Trick Wheel Control Of Needle Selection

THE principal methods of producing knitted patterns in rib goods are as follows: (1) the welt stitch method in which the cylinder needles are selectively raised to receive the yarn at either of two feeds carrying yarns of contrasting colors; (2) the wrap or embroidered stripe principle in



Brinton trick wheel glove machine.

which ornamenting threads are crocheted into the surface wales of a basic rib fabric by passing the threads around individual needles in the needle cylinder; and (3) the accordion stitch principle whereby the color supplied at any feed of a multiple-feed machine may be caused to appear on the face of the fabric by raising selected needles to the clearing position at that feed or causing it to remain at the tuck position at that feed in which case the color does not show in the face wales.

The Welt Stitch Principle

The welt stitch principle may be incorporated into machines containing a single set of needles. The yarn which is not taken by the needles at any feed in this case is floated on the back of the fabric. In the rib machine this yarn is knitted by the dial needles. In a two-feed machine the fabric will show continuous knitting on the back with the courses alternating in the two colors knitted. The face of the cloth will ordinarily have a figured pattern formed from one of the colors upon a field of the other color. The needles knit one but not both of the colors on any one revolution. It can be seen readily that the face of the cloth will have only half as many stitches per inch as the back of the cloth. In larger machines with three or some multiple of three feeds, three-color patterns may be made in the same manner. For simplicity in explanation, a trick wheel machine for making figured jersey cloth will first be discussed. The machine is equipped with a single set of needles carried by a needle cylinder and sinkers similar to those used in a circular hosiery machine. In small diameters the machine is adapted to knitting tops for children's fancy hosiery, mittens and gloves. In larger diameters the same principle is employed in knitting fabrics for sweaters and various articles for outerwear.

Fig. 31 is a view of the machine head showing the special features of a machine of this type. It will be observed that the cylinder is taller than that of an ordinary machine and is surrounded by two circular plates, the upper one 9 carrying the knitting cams 16 and the yarn guides 8 while on

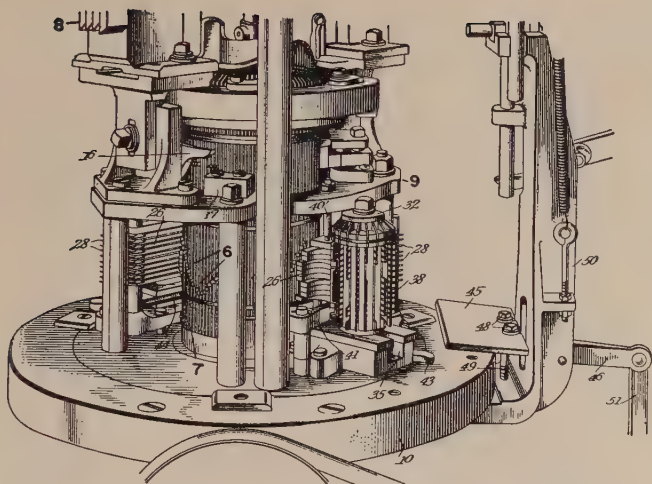


Fig. 31—Diagram of the trick wheel knitting machine (Brinton).

the lower one is mounted the pattern mechanism. The pattern mechanism consists of needle jacks 7 and pressers 6 placed under each needle in the same slot. The needle is raised to the knitting level only through the jacks which may be selectively pressed off its raising cam through a series of trick wheels 32 each carrying through a group of pressing cams 26.

Fig. 32 is a view of the needle cylinder showing the arrangement of the jacks, pressers, needles and cams. The cylinder is equipped with needles of the non-friction type which are retained in place by two spring bands 18 and 19. Under each needle is placed a spring jack 13 for lifting the needle upward by a projecting shoulder 14. Over each jack is placed a presser 24 with butt 25 which may be operated upon to press the jack entirely into the needle slot so that its butt is not lifted by the jack raising cam 22. In Fig. 33 6, 7 and 8 show three essential positions of the needle and jack in forming the welt stitch. At 6 the needles are in the lowest position. The clearing cam 17 cannot engage and lift the needle to the knitting position unless the jack raises it a short distance. At position 7 the jack riding over the jack cam 22 has elevated the needle so as to cause it to be

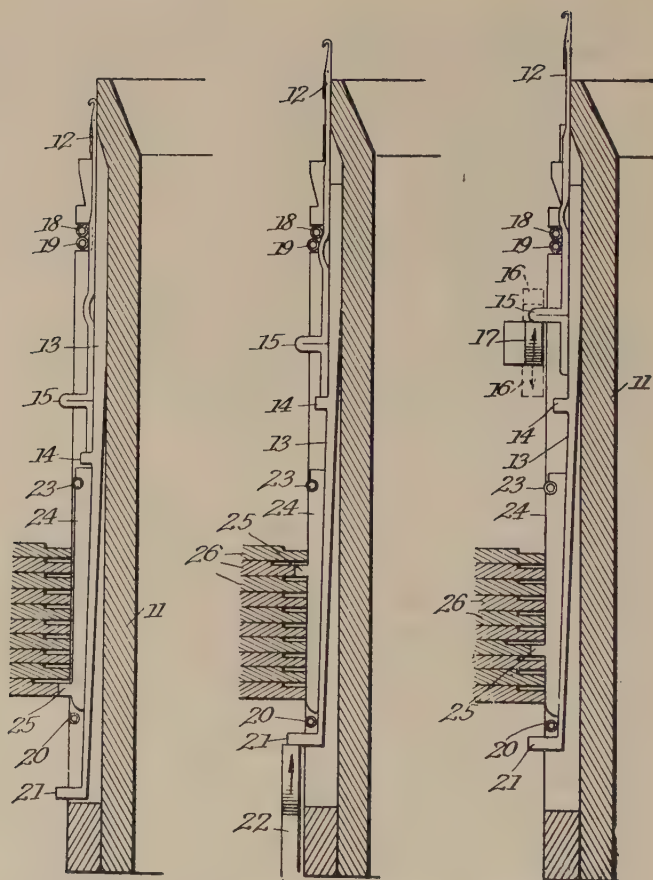


Fig. 32—Sectional views of needle cylinder, showing relation of needles, pressers, jacks and cams.

lifted to the knitting position by cam 17. On reaching position 8, the latches have been cleared by the raising cam and cast off their stitches on passing under the stitch cam 16. For plain knitting the presser cam 22 does not make contact with the pressers. The trick wheel is idled with a blank trick opposite the presser cams and therefore permits all jacks to ride over the raising cam and place all needles in the knitting position.

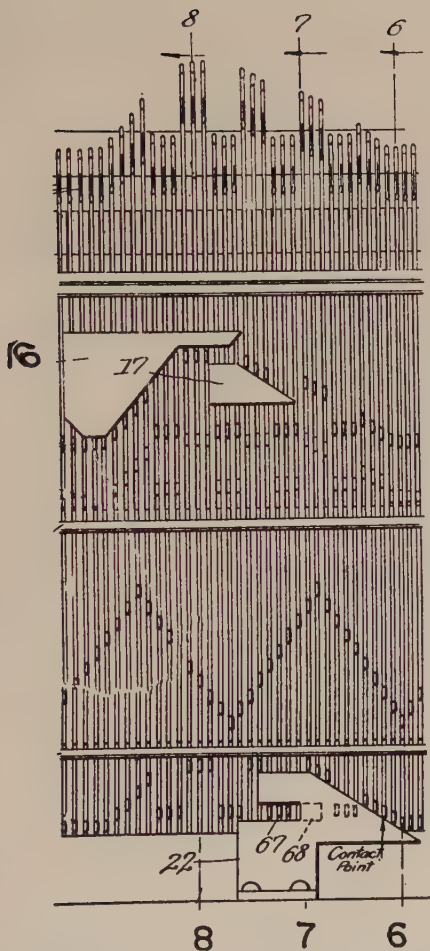


Fig. 33—Needle cylinder, showing three essential positions of the needles in forming the welt or float stitch.

In the figured area of the top the trick wheel is in action and presses the jacks according to the location of butts in the trick wheels. The production of a pattern is effected by feeding different colors of yarns at successive feeds which for explanation may be designated as black and white. It is obvious that if a needle or group of needles is raised at only

the white feed, the wales formed by these needles will be entirely white. Since the black yarn is not engaged by the needles in question, will float across the back of the white fabric and be entirely covered. In like manner if the adjacent needle or group of needles is raised at only the black feed, the fabric formed by them will be solid black. The white yarn in this case will float across the back and be hidden.

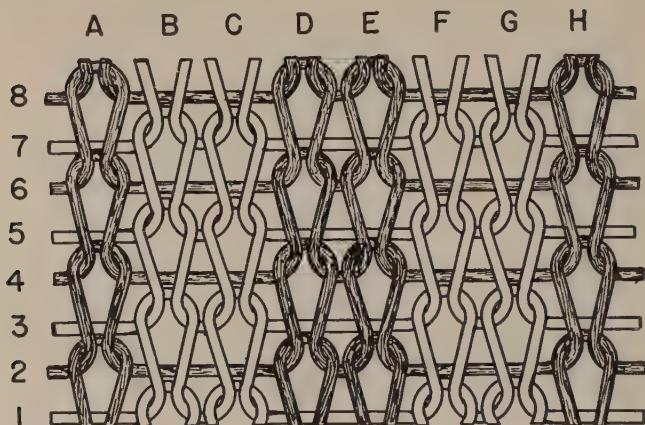


Fig. 34—Diagram of the stitch formation in a jersey-type trick wheel fabric.

The principle is illustrated diagrammatically in Fig. 34 which shows a black and white striped fabric, each stripe being formed over the width of two needles. The area illustrated covers eight wales designated as *A, B, C, D, E, F, G* and *H*, and eight courses designated as *1, 2, 3, 4, 5, 6, 7* and *8*. The wales are colored two white and two black, and the courses one white and one black. On the first course the needles for wales *B, C, F* and *G* are lifted to receive the yarn. The other needles remain in the idle position thus permitting the yarn to float across the space occupied by them. On the second course (black) the needles for *A, D, E* and *H* are lifted to receive the yarn which floats over the space occupied by needles *B, C, F* and *G*, since they remain in the idle position. Repetition of this order of lifting results in the production of a striped fabric.

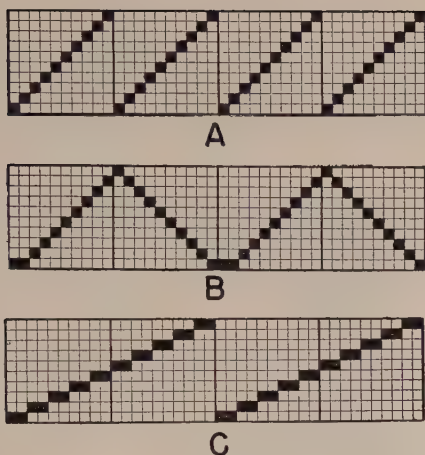


Fig. 35—Various types of presser arrangements.

The design possibilities of a machine of this type are, however, not limited to the production of striped patterns. The pattern and ground may take any required shape depending on the arrangement of pressers. There are 18 types of pressers, each having its butt located in a different plane on the surface of the needle cylinder. This enables the pattern to cover a distance of 18 wales with the presser butts arranged according to Fig. 35A. Fig. 35B shows a V or point arrangement whereby the width of the pattern may be extended to 20 wales with ten pressers provided it is symmetrical. Fig. 35C shows a third possible arrangement of the pressers which enables the pattern to be extended to 20 wales, using ten of the 18 possible presser butt positions. The pressers are arranged in groups of two, each group having butts in the same plane. This arrangement provides for two-needle control. In planning a presser arrangement it is necessary to take into consideration the number of needles in the cylinder. It is desirable to have the pattern and presser arrangement repeat on some factor of the number of needles in the cylinder. This is, however, not absolutely necessary as a difference of one or two needles in some of the repeats is hardly noticeable provided the extra needles are thrown in the ground area of the pattern. The vertical repeat

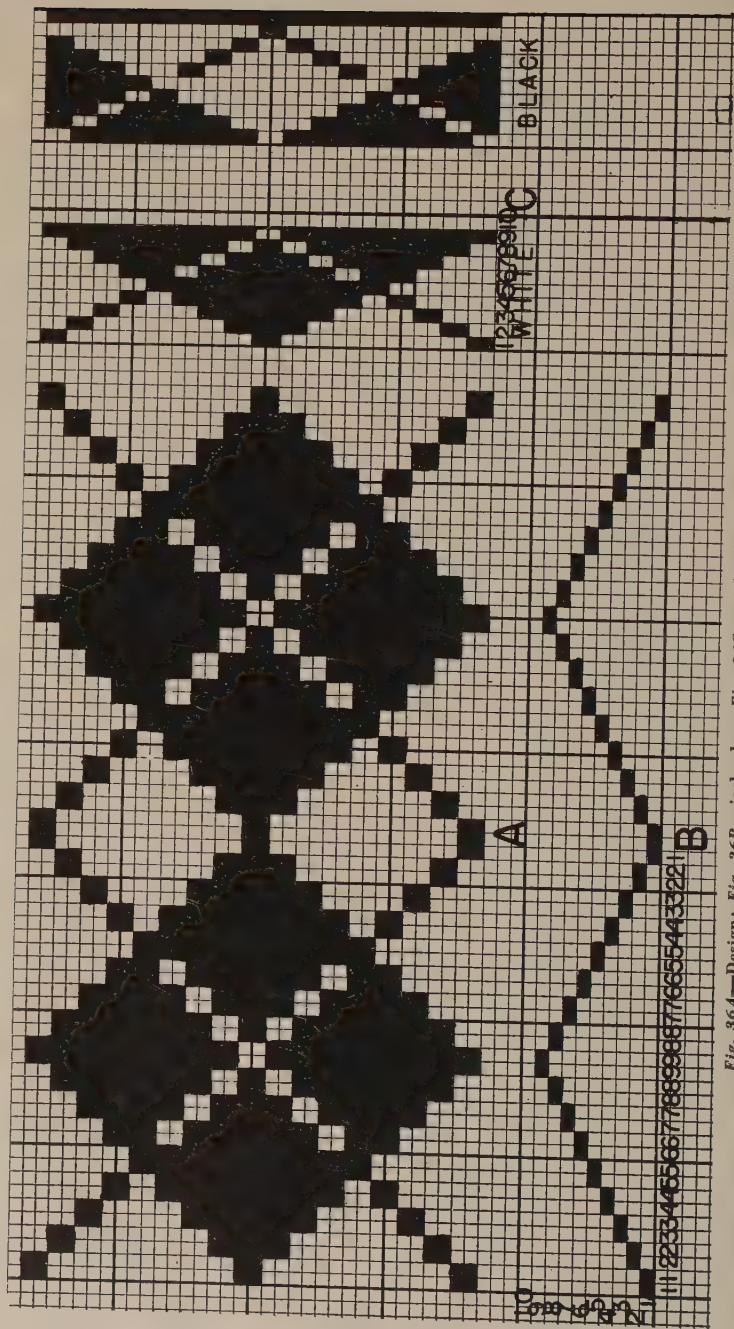


Fig. 36A—Design; Fig. 36B—jack plan; Fig. 36C—trick wheel plan (for two-color fabric.)

of the pattern may be either 20, 40, or 60 courses since trick wheels are built with up to 60 tricks, each of which represents one course of knitting if the wheels are continuously indexed. Unless the pattern is to be an all-over effect, there will be at least one blank trick in each wheel to produce regular knitting between the figured areas. Patterns which are not symmetrical may be constructed on an area of 18 wales and 60 courses with a different coloring on each wale. Fig. 36A is an example of a two-color pattern constructed for a two-feed machine to manufacture tops for boys' sport hose. The repeat covers an area of 33 horizontal and 34 vertical squares. Each vertical row of squares represents a wale, and each horizontal row of squares represents a course. The vertical repeat of 34 courses is not a factor of the 60-cut trick wheel, and it is assumed that this pattern will be produced as a border pattern with the wheel built plain for the remaining 26 courses.

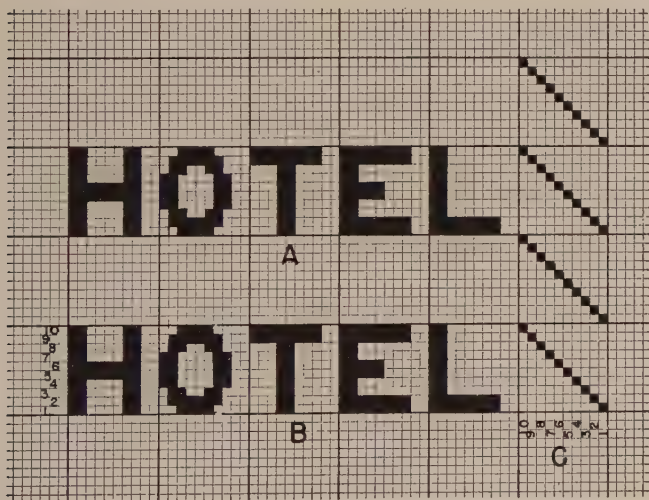


Fig. 37—Example on non-repeating design. The design (A) is reproduced in the jack butts (B) and the trick wheel (C) is a straight diagonal in ten steps.

Fig. 36B is the presser arrangement for Fig. 36A. Beginning on the left and proceeding to the right, each wale in the design above is numbered from one upward according

to the order of coloring. All wales having the same order of coloring are given the same number. These numbers, one to nine inclusive, correspond to nine types of pressers and indicate the position of the presser butt in the presser arrangement.

Patterns may be made by using pressers with more than one butt. To make a non-repeating pattern covering a wide area, such as a monogram or letter design, the letters are delineated in presser butts on the cylinder itself instead of the trick wheels. The trick wheel in this case has its butts arranged in diagonal order from one to ten. Fig. 37A is a design of this type. It is the same as the presser arrangement B. Fig. 37C is the layout for trick wheel. Only one trick wheel can be used in a design of this type, consequently the pattern will appear in solid color upon a ground of alternate courses of the two colors used.

The Trick Wheel

The trick wheel is slotted to receive tricks with butts corresponding to the presser butts and set relatively to the presser cams. The tricks are held in place by the spring band and may be removed from the wheel and new ones substituted when a change in pattern is to be made. Each trick represents a course when the wheel is advanced one trick for each revolution of the machine. It is, however, possible to repeat any number of courses by stopping the pattern wheel for that number of courses. This is often done in forming stripes, blocks and checked patterns where there are a number of courses with the same coloring. It will be observed that to hold a presser in for one revolution, it is necessary to have a trick butt on the trick wheel representing that course, and if more than one cam is to be in during a course, there must be a butt on the trick for that revolution corresponding to each of the presser cams. When all needles are to knit during a course, the tricks will be blank, but if no needles are to knit during the course, the trick will be solid. The tricks are made with 18 trick butts, but less than this number may be used if the removal of the

extra butts in building the pattern may readily be accomplished with a punch and hammer.



Fig. 38—Two-color trick wheel rib fabric.

Two-Color Pattern on a Three-Feed Machine

As a rule, three-feed trick wheel rib machines are used with a different color of yarn for each feed. If two-color yarn changers are applied, each feed may carry two colors making a total of six colors for the three feeds. The fabric may thus be knitted in three colors in one section, and three in another by changing yarn at each feed at the second section.

It often is necessary to make a pattern on this machine with less than the full number of colors. This is easily arranged by properly building the trick wheels. Fig. 38 is a fabric made on a three-feed machine of the ribber type, one feed carrying an end of 30/2 blue worsted yarn, the other two each carrying one end of 30/2 yellow worsted. Fig. 38A is the design for this fabric with one horizontal repeat of 40 wales each and five vertical repeats of ten courses each. Fig. 38B is the presser arrangement which is in straight diagonal order on ten butts. Figs. 38C₁ and 38C₂ are the presser arrangements for the trick wheels, the first one being the layout for the yellow feed used in forming the figure. It will be observed that the layout is the reverse of the design. The second layout is for the blue feed used in

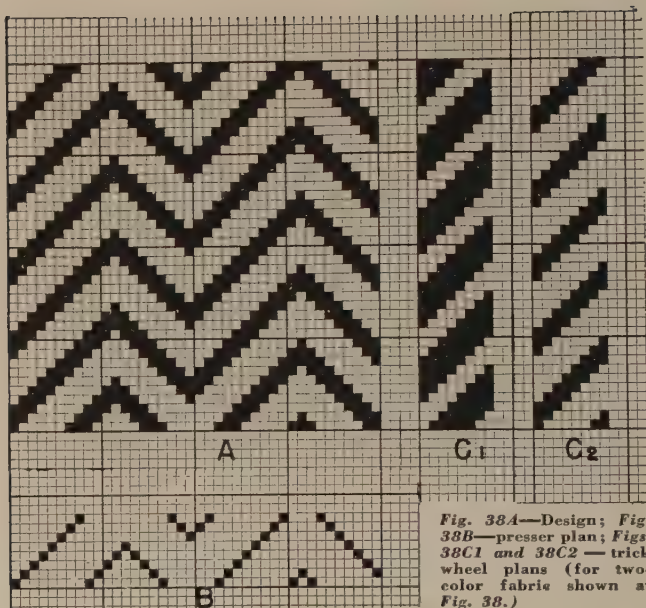


Fig. 38A—Design; Fig. 38B—presser plan; Figs. 38C1 and 38C2—trick wheel plans (for two-color fabric shown at Fig. 38.)

forming the ground. The yarn supplied at this feed is knitted by the dial needles into the back of the fabric. The trick wheel is therefore solid and is built from the tricks as received with none of the butts removed.

This fabric is knitted on the one and one rib stitch base, the machine being essentially the same as that illustrated at Fig. 31, with the exception that the dial is used in place of the sinker top. Besides being more elastic, the fabric produced on a machine of this type does not have the objectionable long floats on the back which are characteristic of the fabric made on the jersey or sinker top machine. The pattern is made entirely on the cylinder needles since these knit the outside of a rib fabric while the dial stitch is regular at all feeds no matter how the order of stitching on the cylinder needles is varied to form a pattern.

Three-Color Designs

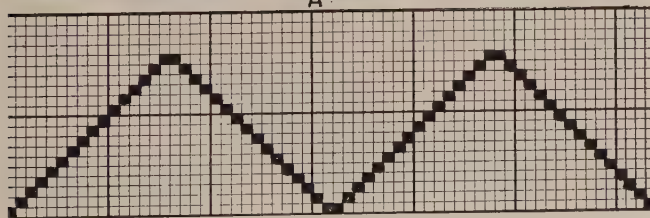
The three-feed trick wheel rib machine lends itself readily



Fig. 39—Three-color rib argyle hosiery top.



A



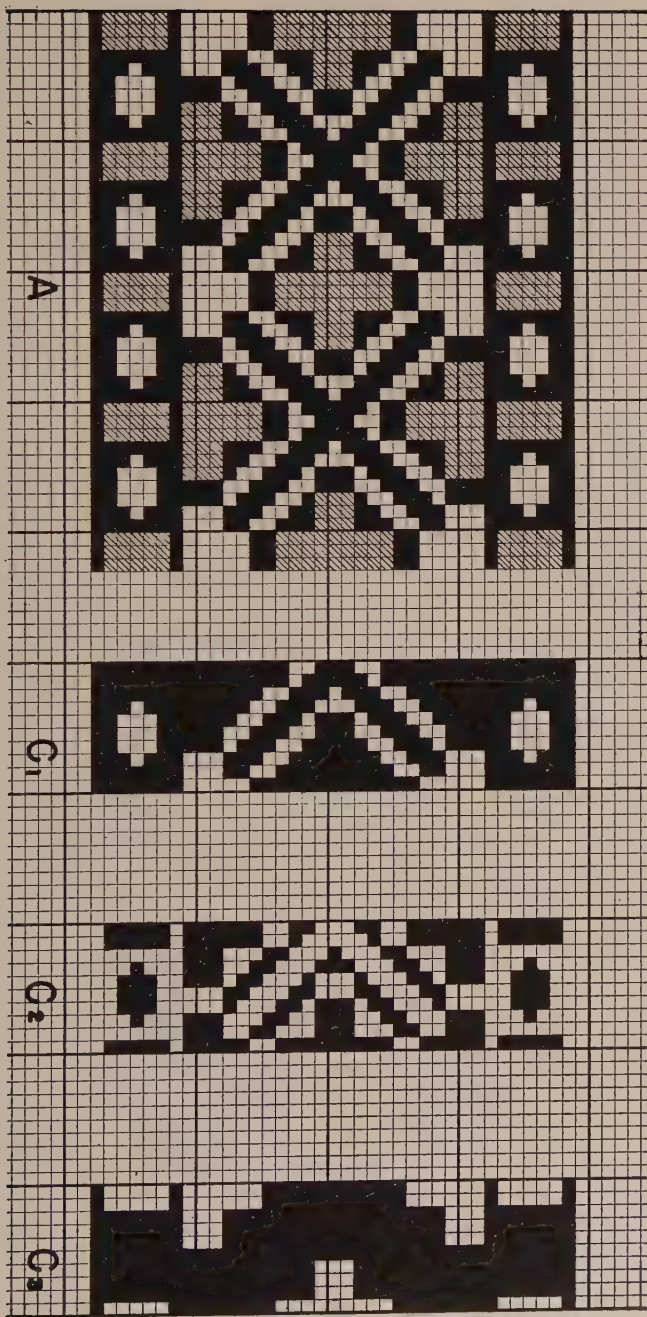
B

Fig. 39A and Fig. 39B—Pattern and presser plan for Fig. 39.

to the production of patterns in three colors, the pattern being developed in two colors upon a third ground color. Fig. 39 is a fancy top in three colors in which the pattern has been developed in dark blue and red upon a beige background. The main pattern and borders repeat on 32 wales and 30 courses. Fig. 39A is the design. Fig. 39B is the presser arrangement. The trick wheel layouts, Fig. 39C— are for the blue, red and beige feeds, respectively. The first trick wheel layout is derived by shading in the trick wheel area all squares which appear in the design as blank and crosshatched. The second trick wheel layout is made by shading for black and white, while the third is obtained by shading the blank and crosshatched area in the second half



Fig. 39C—Trick wheel plans for Fig. 39A.



Figs. 40A and 40C—Design for three-color pattern.

of the repeat. Each horizontal line of squares in the trick wheel layout represents a trick and one course of knitting.

Fig. 40A is a second three-color design showing how new patterns may be made without altering the presser arrangement. This pattern was produced on a three-feed machine with the same presser arrangement as Fig. 35B. Figs. 40C₁, 40C₂ and 40C₃ show the trick wheel layouts for the white, black and gray feeds, respectively.

Trick Wheel Drive

The trick wheels are advanced one trick or six degrees for each revolution of the machine and make a complete rotation for each 60 turns of the machine head. Fig. 41 shows a top view of a trick wheel *F* which is adjustably mounted with the stud *H* in the slotted plate *I*. The trick wheel may thus be advanced or moved further away from the needle cylinder *J* so as to exert the proper amount of pressure upon the presser cams *K*. The trick wheel is mounted on the revolving head of the machine and turns with it in the direction of the arrow. Located on the back side of the machine is a plate *L* which is brought into the plane of revolution of the trick wheel operating lever *M* for the figured area of the fabric or elevated above it thereby idling the trick wheels for any plain areas. This makes possible the production of the fancy top and plain leg all in one piece, the foot being attached by transfer to a footing machine or by a sewing machine.

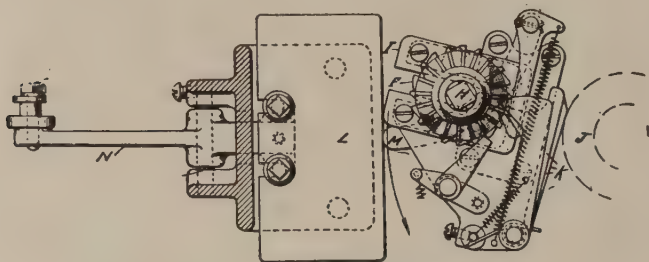


Fig. 41—Trick wheel driving mechanism.

Setting and Timings

To adjust a rib machine of this type for perfect knitting it is necessary to time the dial stitch with the cylinder stitch. The dial stitch should be cast off one half to one needle after the cylinder stitch is formed, depending somewhat upon the gauge of the machine. As a rule a short stitch on the cylinder needles, and a comparatively long stitch on the dial needles produces a superior fabric. In case the fabric is streaked, it should be examined for defective needles. If the needles are all in line, the dial cap should be moved to the left so as to cast off the dial stitch later.

Chapter IV. Rib Fabric Production For Underwear And Outerwear

ONE type of circular latch needle machine is the stationary needle cylinder in which the cam ring, cam dial plate, bobbin rack, stop motion and crossbar revolve. As the needle cylinder and the cloth are stationary, the take-up is fixed to the frame, but the feeds and the bobbins as well as the crossbar must revolve. These parts, with the cam ring and dial plate, compose the head.

Fig. 42, the Scott & Williams circular latch needle automatic body machine, is representative of this type of machine with the revolving head. The more notable difference that may be observed in this illustration is the manner of applying the take-up to the frame, as the cloth is not revolved.

The cam ring, carrying the cylinder needle actuating cams, revolves around the stationary needle cylinder and thereby acts on the butts of the needles, moving them up and down with the required amount of travel to effect the formation of the stitch. The cam ring contains all the cams for operating the needles in the needle cylinder. The cam projection, Fig. 43, and the section illustrated in Fig. 44, show the disposition of the cylinder needle actuating cams in this machine, and their relation to one another.

The cover cam *A*, Fig. 43, is merely to guard the needles and prevent them from vibrating while the machine is running. It has no function to perform in making the stitch. The front part of the clearing cam *B* raises the needles to a tuck point, so that all the latches are safely opened before the yarn guide covers the needles to feed them new yarn. The highest point of the cam is the clearing point for placing the old loop under the latch in order that it may be cast off the needle over the new yarn to make a new loop.

The stitch cam *C* draws down the needles to knock over the old stitch and at the same time draws enough yarn for

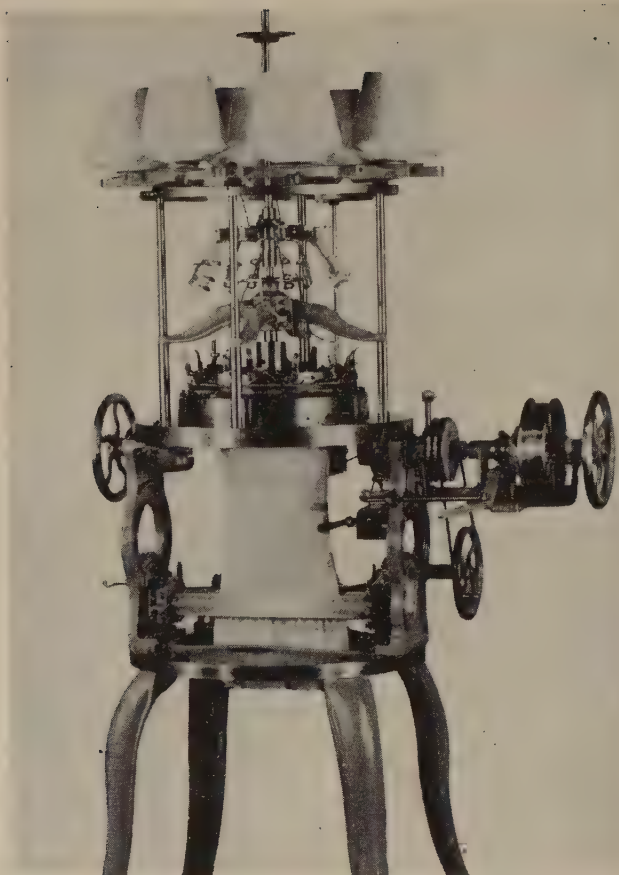


Fig. 42—Plain rib body machine (Scott & Williams).

the new stitch. This yarn is laid over the dial needles near the latch rivets and is of sufficient length to also form the dial needle stitch, so that this cam *C* regulates the length of stitch for both cylinder and dial needles. The dial needles are merely drawn in far enough to cast off their stitches. In Swiss or Richelieu knitting the cylinder and dial needles draw their stitches independently. Both reach the limits of their draw at the same time. This requires steeper cam angles but results in a more elastic fabric. This principle is

often used in making 2x2 fabrics and is the one generally followed by foreign machine manufacturers, although at a sacrifice of speed.

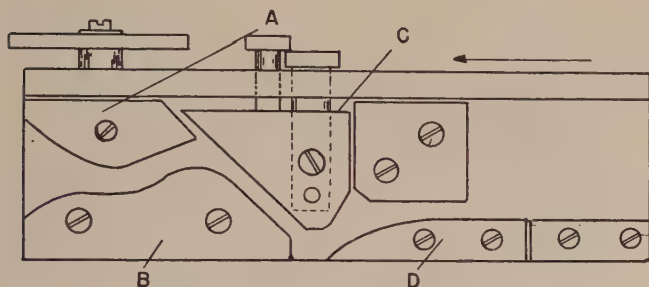


Fig. 43—Cylinder cams in development.

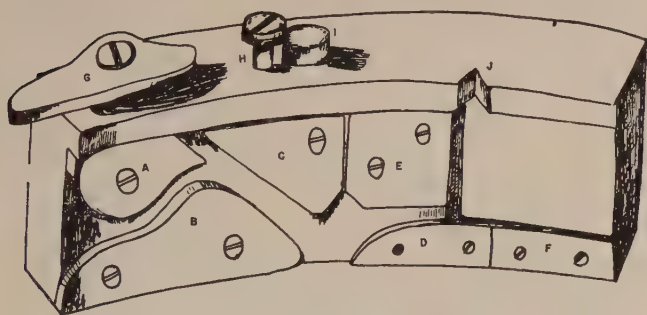


Fig. 44—Section of cylinder cam ring showing needle cams.

The rest cam *D* returns all the needles to one common level after the stitch has been formed. The main object is to even the length of the stitches. Without this cam a tight or stiff needle would make a slack line in the surface.

The center part of the cam *B*, for the dial needles shown in Fig. 45, performs the same function as the rest cam *D* in the cam ring, projecting the needle heads slightly beyond the edge of the dial to relieve the strain on the loops. The back part of the cam projects the needles to the tuck point to open the latches before the yarn guide covers the needles for placing a new stitch on them, performing the same function as the front part of cam *B* in the cam ring.

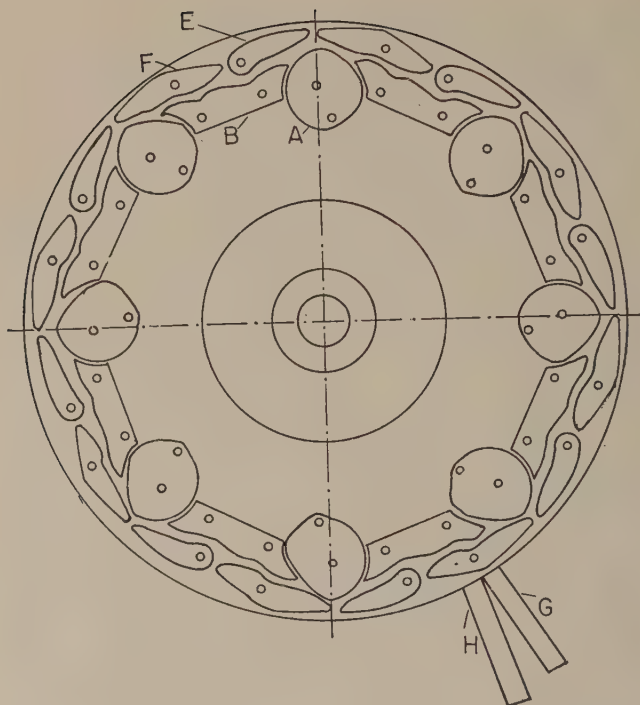


Fig. 45—Diagram of dial cams of an eight-feed rib body machine.

The clearing cam *A* corresponds to the highest part of cam *B* in the ring and the cover cam *F* to cam *A* in the ring. The draw-in cam *E* casts off the old stitch placed on the dial needles by the cylinder needles. This cam also acts as a dividing cam for the top loops. It has nothing to do with the stiffness of the fabric.

The cap or dial plate, Fig. 45, contains all the cams for operating the needles in the dial. The clearing cams *A* are controlled by a ring automatically operated by the levers *G* and *H* for moving alternate ones inward to produce tuck stitches when producing royal fabric used in making ladies' shaped vests and union suits. These cams *A* can be fastened either in their inward position to make tuck stitches or in their outward position to make plain stitches or any number

can be controlled by the ring for making fancy stitches in lace work. When used in connection with a movable cam in the ring of two or more feeds a full cardigan stitch can be formed.



Fig. 46—Body machine cylinder and dial (solid wall type).

Two types of cylinders are used in the stationary cylinder machine. The one type, Fig. 46, is made from a solid piece of forged steel with the needle slots cut to the proper gauge. The other type, known as the inserted wall type, has thin pieces of sheet steel inserted to form the needle tricks. A cylinder and dial of this type are illustrated at Fig. 48. The trick walls may be removed when damaged by heating the cylinder or dial at the damaged portion. New ones may thus be inserted and slightly damaged cylinders and dials made as good as new.

The cylinder and dial are two of the most important parts of any rib knitting machine. The perfection in design and setting of these parts determines the facility with which knit fabric is produced. The dial is not only a receptacle for so many needles; it has another function to perform. The outer edge of the dial acts as a knocking-over ledge for the inside or dial stitch.

Adjusting Stationary Cylinder Machines

The following instructions apply in most part to revolving head machines, though more particularly to the Scott & Williams frame, which is so generally used in this class; and includes directions for adjusting a machine that has never been run, or which has been out of use for some time.

Clean off the machine thoroughly and see that the working parts are well oiled, taking care to oil the cylinder and dial only slightly with a light stainless oil. Belts of nearly the full width of the receiving pulley should be used, and run at an angle that will not interfere with the belt shifting fork. Fill both cylinder and dial with the necessary needles, after having removed all those broken, bent, or otherwise disabled, and see that the latches work freely and cover the hook perfectly.

Adjust all the dial draw-in cams to draw needles about $\frac{1}{32}$ nd of an inch inside the diameter of the dial. Set all cylinder draw-down cams to draw the needles about $\frac{1}{16}$ th of an inch below the top of the cylinder. Adjust the cap circumferentially until the hooks of the cylinder needles meet the rivet of the dial needles.

Set the height of the dial so that a needle will pass freely between the edges of the cylinder and dial, or leave a space between the cylinder and dial wide enough so that the old fabric to be used in setting up the machine will pass freely between the cylinder and dial at the place where it will be joined to the new fabric. This adjustment must be made by the threaded wheel and center spindle at the top of the machine.

Fit all the yarn guides to the machine. The yarn guides,

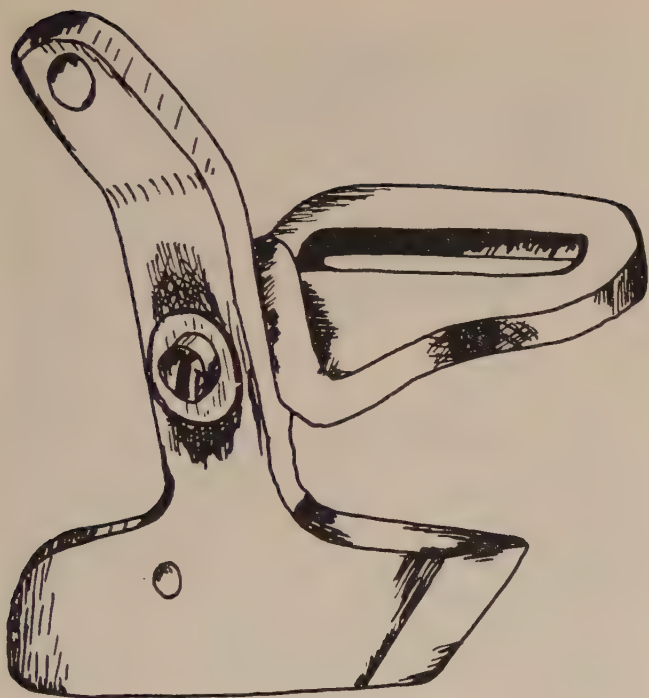


Fig. 47—Yarn carrier.

Fig. 47, should not touch needles at any time, but should be set $\frac{1}{16}$ th of an inch above dial needle and about $\frac{1}{32}$ nd of an inch away from the cylinder needles. The circumferential position of the guides should be such as to allow the cylinder needle latches to close without striking the guides. The leading end of the guides should then cover both the cylinder and dial needle latches just before the latch passes through the fabric. This prevents the latches from closing after leaving the control of the fabric on the old loops.

If there is no fabric on the machine, take a tubular piece of cloth of about the same diameter as the needle cylinder. Press up the machine by placing the fabric between the cylinder and the dial dogs. To do this insert a needle down through the space between the cylinder and dial, and with the hook of the needle, catch a narrow hold on the edge of

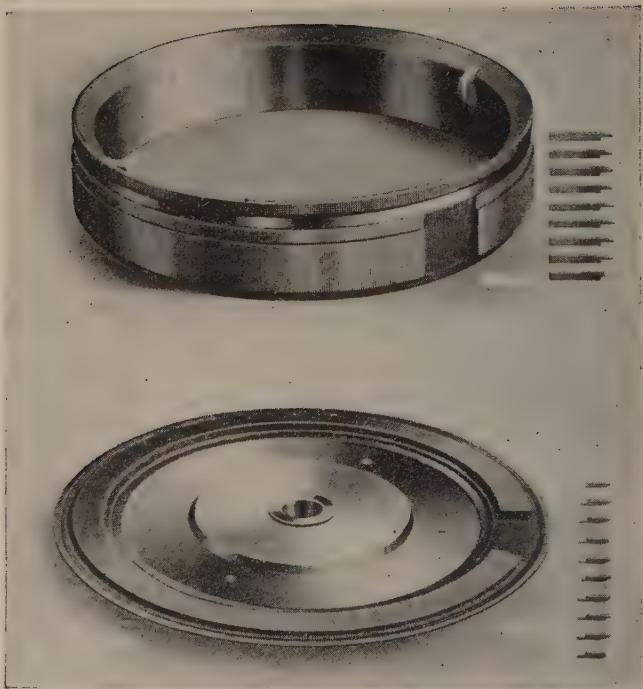


Fig. 48—Body machine cylinder and dial (inserted wall type).

the fabric which is to be placed on the needles, and pull it up until it can be grasped by the fingers of the right hand. Put the left hand underneath and up through the hole in the needle cylinder, grasp the fabric, and by means of a sawing motion, force the fabric between one of the sets of dogs which prevent the dial from turning.

The machine should be turned at this time so that one of the resting points for the cylinder needles will come where the work is inserted between the cylinder and dial. At such points the cylinder needles are partially elevated, so that the edge of the fabric may be easily pulled on to the needles. Too wide an edge would make it difficult to operate the machine, and too narrow a bite would allow the cloth to be easily pulled off the needles. About $\frac{1}{8}$ th of an

inch from the needles to the edge of the fabric, or slightly less, will be found sufficient in most cases.

After the fabric has been pressed on to several needles at this point, it is well to go around to the other side of the machine and pull it up between the other sets of dogs, and place it on about the same number of needles, going through the same operation as before. Then press the cloth on to a few needles at the other feeds, and turn the machine slightly, repeating this same process until the fabric has passed under the yarn guides.

Thread the guides and hold the work down by hand, catching hold of the cloth under the head with the left hand, while turning the machine slightly to bring other groups of needles into accessible positions to place the rest of the fabric on the empty needles. Repeat this operation until all the needles have loops placed upon them, then place the other end of the fabric between the take-up rolls, and adjust them to have a fairly taut tension on the fabric. Too much tension should not be applied until the rough edge of the run on portion of the cloth is off the needles.

If all the yarn guides are properly threaded, the machine may be slowly turned by hand a short distance at a time, meanwhile opening all the latches that have not been opened by pressing up and picking up all the dropped stitches and placing them on their proper needles. At this time the cylinder and dial may be thoroughly oiled. Oiling was done but slightly before placing the fabric on the machine, as excessive oiling before that operation makes a machine hard to press up. The oil affects the yarn and fabric to such an extent that it is almost impossible to get the needles through the fabric.

If the hooking-on seems fairly secure, start the cloth in the take-up. But if it is not secure, it is well to use hand tension a little longer, since if the stitches start to break, the hand can let up quickly, whereas the take-up may pull the fabric entirely free before the tension can be released. It is well to have the cloth in the take-up before the power is put on, since the take-up pull is much more dependable than the hand pull.

After the power is put on, watch all around the needle line for loose yarn and if any appears that does not quickly knit down, stop the machine, or the needles will become clogged, in which case hooks and latches get bent, latches get bruised by the carrier and butts get cut off. Pull the loose yarn clear of the needles, taking care not to injure the latter, and hook a small piece of cloth on the bare needles and keep hand tension on it until the hole mends; or if the space is not large, take out the dial needles there, in which case the cylinder needles will generally pick up, after which the dial needles may be replaced and the rib knitting will start at once. For multiple-feed machines the operation is substantially the same, except that each feed must be threaded just before the fabric comes to it and all of the feeds should be watched to make sure that they are clearing the stitch properly until the raw edges are down out of the way, after which there is not much danger of trouble.

Another method of replacing a press-off practiced by some knitters (assuming that the cloth is between the cylinder and dial and the first set of dogs, and on the needles), is to keep jabbing it on to the needles a little at a time, turning the machine slowly until the first yarn guide and set of cams come to the point where the work was started on the needles. Then thread the guide so that the needles will begin to knit, and proceed to place the work on the needles in continuous order, threading up the several guides as they come into position until the other set of dogs is reached. Get the work in between these dogs by the process described above and continue to jab on the work continuously all the way around to the starting point, taking care that each guide is properly threaded when it arrives at the starting point. Then put the other end of the cloth into the take-up rolls and proceed as before.

In adjusting the feed, run the machine carefully until the new fabric has passed through the take-up rolls. In the meantime set all the cylinder cams evenly, by marking all the threads an equal distance from the yarn guides. To prevent unevenness of the cloth, each feed should draw exactly the same length of stitch. When unevenness of

fabric appears in the cloth, it is often very difficult to locate the particular feeds that are not in adjustment. The common practice of marking the yarn of each feed is the simplest and perhaps the surest way of detecting which feeds are drawing more yarn than the others.

To do this effectively, twist the yarn between the fingers, which have been soiled with oil or lipstick, so that the marking on the yarn may be easily noted. Place these marks at one of the guide rings on the bobbin stand rod. Then turn the machine slowly by hand until the marked places on the yarn reach their particular guides. If all the marks arrive at the holes in the guides at precisely the same time, the fabric will be uniform. If one or more of the marked places arrive at the holes in the guides in advance of the others, they are drawing more yarn, and should be adjusted accordingly. The cam drawing the longest loop will necessarily draw the mark to its guide first and should be slightly raised by means of the adjusting screw. The yarn with the mark farthest from the guide should be slightly adjusted downward to make it draw a longer loop. This operation must be repeated until all the marks on the yarn arrive at the holes in the guides at precisely the same time.

In adjusting the dial cap see that all the cap draw-in cams are set to draw the head or hook of the needle through the stitch. The adjustment of the cap which operates the dial needles should bear a certain relation to the cam ring which actuates the cylinder needles. The cylinder needle should be made to draw down just in time to lay its thread on the latch directly to the rear of the rivet in the dial needle. This relation is governed by the circumferential adjustment of the cap on the center spindle.

Now run the machine long enough to get an even weight on the fabric and to adjust the take-up rolls so that they will have a uniform tension to make the fabric pass through evenly. At the end of the rolls it may be seen whether the fabric is being drawn through too fast or too slowly. If one end is slack it is evident that there is a lack of tension on that particular end. At each end, there is a separate adjustment by means of which the fabric may be made to

run evenly and smoothly. The take-up rolls should not be pressed together too firmly and must be parallel to draw equally at both ends.

After making the above adjustments the knitter must determine what weight of fabric is desired, and adjust his machines accordingly. If only a slight adjustment of one or two stitches per inch is required to obtain the proper weight of fabric, it can be made by adjusting the dial spindle wheel. But for more than one or two stitches per inch, the adjustment should be made on the cylinder draw-down cams. This adjustment requires the marking of yarn as previously described, to insure a perfect evenness of the fabric after the proper weight has been obtained.

To slacken the fabric, either lower the draw-down cam in the ring, so that the needles will draw more loop, or raise the dial by loosening the retaining screw in the cross-bar. Then turn the dial spindle wheel in the direction calculated to raise the center spindle. The cap and dial will come with it. As a rule, it is not good practice to have the dial any higher than just enough to give ample space to permit of a free passage of the thickest portion of the work. Further slackening of the cloth should be obtained by adjusting the draw-down cam in the ring as described.

The sectional cam ring is provided for the purpose of obtaining easy access to the needle cylinder to inspect or replace cams and to repair cylinder tricks which may be damaged by broken needles without removing the entire ring. After releasing the tension on the work by turning the belt pulley backwards to slacken the take-up rolls take out the retaining screw which passes through the solid outer ring, and remove the central section. It will then be possible to draw the cam section away in a direct line from the needle cylinder and expose the needle cylinder so that the difficulty may be located, and the broken needles or cams removed and replaced by new ones.

To restore the sections to their proper places, adjust the needles to conform to the space between the cams of the inner section. Push this section up to the cylinder, drop in the central section, and secure it with the retaining screw.

Draw the work down through the take-up rolls to get the proper tension on the cloth, turning the machine partially around by hand to see that everything is working properly. Then apply the power.

When the fabric is being examined to see that the knitting is perfect and clear of any tuck stitch, it will be found that the holes and tuck stitches often occur through the failure of the cap draw-in cams to draw the dial needles clearly through the stitch. If the machine is cutting holes in the fabric without the presence of the tuck stitches, it may be prevented by setting the cap draw-in cams outward. Too much strain at this point cuts the yarn when knitting.

The cylinder not only holds the lower needles, or needles which make the outside of the fabric, but the cylinder top or comb acts as a landing or knocking-over point for the cylinder needles. The cylinder top or comb also acts as a knitting point for making the welt on a welting machine, as the dial needles are thrown out of action at this point of knitting.

The take-up, besides performing its function of drawing the knitted fabric from the needles as it is being made by the succeeding courses formed, is also employed as a weight or tension to assist the opening of the needle latches, when the needles are clearing the old loops, prior to forming a new stitch. The take-up is also an important factor in forming the loops, as it is necessary to employ weight enough to carry the old loops out of the path of the needles without cutting the fabric. It also stops the machine in case of a press-off or partial press-off of the fabric by a connection to the belt shipper or clutch.

It is good practice to use eight needles to the inch for shaped goods, and ten to 11 needles to the inch for straight goods. The gearing of the machine varies with the size of the cylinder but as a rule driving pulleys of the same diameter on the driving shaft will produce the correct speed in the various sizes. Details of gearing and particulars of driving are contained in the following table (next page):

Size of Machine	Speed of Head	Teeth in Ring	Teeth in Pinion	Diameter Driving Pulley	Width Driving Pulley
7	85 rev.	120	30	7"	1½"
8	80 "	130	30	"	"
9	75 "	140	30	"	"
10	70 "	150	30	"	"
11	65 "	130	26	8"	1¾"
13	55 "	138	26	"	"
14	50 "	154	26	"	"
15	46 "	162	26	"	"
16	44 "	170	26	"	"
17	42 "	178	26	"	"
18	40 "	186	26	"	"
19	38 "	194	26	"	"
20	36 "	202	26	"	"
22	34 "	219	26	"	"
24	30 "	234	26	"	"
25	29 "	244	26	"	2 "
26	28 "	254	26	"	"

The speed given here is a good average, but certain conditions require, perhaps a lower speed, and on the other hand, may admit of an increased speed. This is wholly a matter of judgment with the knitter for the nature of the yarn, its condition, the manner of winding, and the climatic influences, in addition to the many other things that are not infrequently coming up to enter into the calculations of speed, are the most important factors in securing good production. When the yarn is running well, the speed may be increased. If it runs poorly and all other conditions are favorable, the speed of the machine will have to be reduced to a point that will manipulate the yarn without too many stops.

The following table gives the total number of needles in each size machine, and the number of cuts in the cylinder, when the number of needles per inch is given:

Cylinder Diameter	CUTS PER INCH IN CYLINDER									
	4	5	6	7	8	9	10	11	12	14
7	87	108	132	156	174	198	222	240	264	312
8	99	126	150	174	204	228	252	276	300	348
9	114	138	168	198	228	252	282	312	336	396
10	126	156	192	222	252	282	312	345	375	444
11	138	174	207	240	276	312	245	372	414	480
12	150	192	228	264	300	336	375	414	456	528
13	165	207	252	288	324	375	408	444	504	576
14	180	222	270	312	354	496	444	480	540	624
15	192	240	288	336	372	432	480	516	612	672
16	204	252	306	354	408	456	516	558	576	708
17	216	270	324	375	432	480	540	588	648	750
18	228	282	342	396	456	516	570	624	690	792
19	240	300	360	420	483	540	600	660	720	840
20	252	318	384	444	504	576	624	690	768	888
21	264	336	396	468	540	600	660	732	804	936
22	282	348	420	492	552	624	690	768	840	984
23	288	372	444	504	588	660	732	804	876	1008
24	300	384	456	540	612	690	768	840	912	1080
25	312	000	000	000	000	000	000	000	000	1125
26	000	000	000	000	000	000	000	000	000	1170

The take-up is driven by a cotton band which may be adjusted when unhooked by twisting or untwisting depending upon whether it is to be tightened or loosened. The stop-off chain connects the take-up with the knock-off handle, and when properly adjusted releases the power if the band becomes too loose or comes off. It does not release the power if the pulley, miter gears or collars become loosened, so they should be tightened occasionally.

The sheave-wheel shaft, worm, and miter gears should be kept well oiled, but the take-up rolls should not be oiled more than is necessary or the oil will run along them upon the fabric. The lightest tension is obtained when the weight hanger-rod is at its greatest extension back of the take-up and all the weights are on it. Moving the rod inward and removing the weights increase the tension, after which further increase is made by reversal of the head of the rod to the front of the machine, addition of weights and increase in its adjustment outward.

To start the cloth between the rolls lift the worm to the top of its shaft and give it a partial turn which will keep it out of mesh. See that the fabric is not twisted; after which place the end between the rolls, turning the latter with the fingers until the end comes through on the lower side, then pull it up through the opening in the leg base, and keep pulling until the take-up stops rising. Give the worm a turn, so that it will drop into mesh, and release the fabric, replacing the end through the opening in the leg base.

To remove the cloth, take hold of it below the take-up and draw it up through the opening in the leg base until the take-up is lifted. This raises the worm to the top of its shaft. Keep the tension on the cloth and give the worm a part turn to hold it up out of mesh. The cloth may then be withdrawn from between the rolls and the take-up is ready to restart.

One of the most frequent troubles is a vertical streak caused by a particular needle. If it is caused by a closed latch, a glance at the needles above the location of the streak will generally show it. If it is not found in this way, take out a dial needle where the trouble seems to be

and run the fabric down below the head base. If the streak has continued, count the number of wales between it and the intentional drop-stitch streak, which is the number of

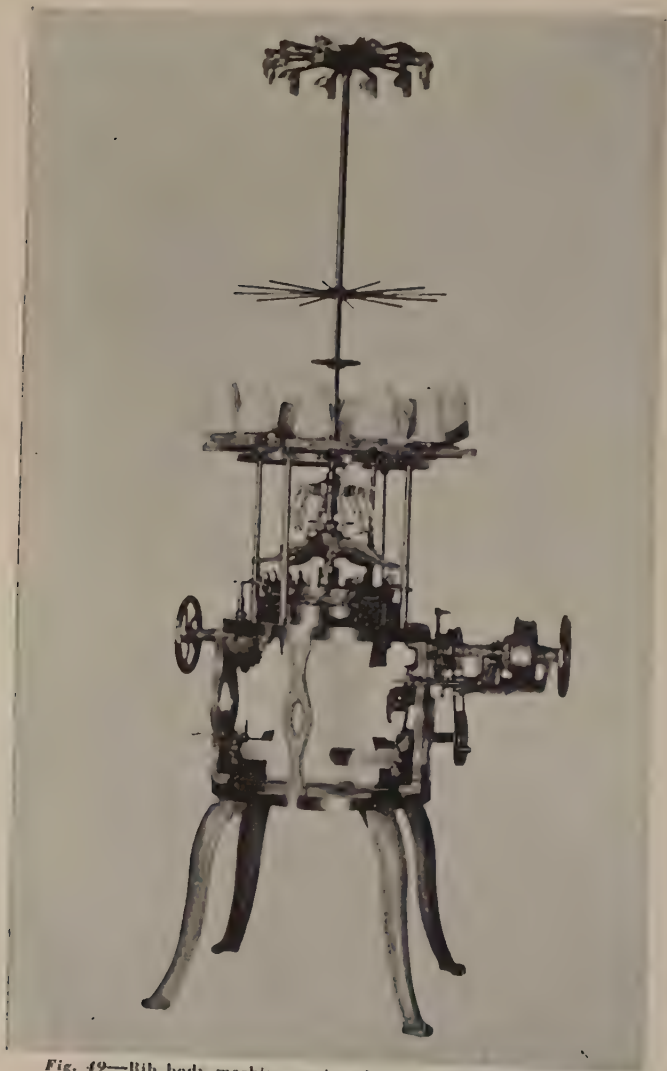


Fig. 49—Rib body machine equipped with electric stop motion.

cylinder needles between the removed dial needle and the defective needle. If the streak is intermittent, as is frequently the case with drop stitches, put the head of a needle, back downward, in the intentional drop-stitch streak and follow down until opposite the last defect; there count the number of needles between the two streaks and locate the defective needle as before.

If the trouble manifests itself in horizontal lines, i. e., along a particular course instead of a particular wale, the cause is at a feed instead of at a needle. Mark the yarn at any convenient feed with a black oil spot, run the spot below the head base and count the courses between the marked course and the one showing the defect. This number is the number of feeds between that at which the mark was made and the defective one. If the defective course is below the marked course, then the defective feed is ahead of the marked feed.

Stitch Adjustment

The stitch is important, not only because it is the essential factor next to the diameter of the yarn which decides the structural characteristics of the fabric, but because correct stitch adjustment is necessary for good results in the operation of the machine. By stitch is meant the length of yarn in the loop. It is necessary to distinguish stitch as applied to the loop from stitches per foot of yarn. When the stitches per foot are increased, the stitch or individual loop is shortened and vice versa. The stitch is determined first by the size of the yarn and thereafter by the requirements of weight, appearance, and feel of the fabric. To lengthen the stitch, that is, to increase the yarn in each stitch, is to lengthen the loop, and to make the fabric loose or sleazy, if the original stitch was normal; and to shorten the stitch, that is, to decrease the yarn in each stitch, is to shorten the loop, and to make the fabric heavy or boardy.

In regard to the running of the machine, too tight a stitch will tuck and load up, whereas too loose a stitch will drop off the needles or pull twist apart. The commonest and easiest way of counting the stitch is to count the num-

ber of courses with a stitch glass. The counting should be done off the machine to eliminate as much as possible the disturbance due to the pull of the take-up, and when a close count is desired, it should always be counted in the same location around the cloth and away from the dog streaks. Counting by courses is a good way when the length of the fabric is important, as is the case generally with pattern fabric. It also eliminates differences due to such yarn characteristics as twist and harshness. But it is not reliable when the weight of the fabric is important.

The most direct method to adjust the stitch is by the number of stitches per foot of yarn. Get the stitches per foot by marking on the yarn two oil spots a foot apart, running them into the machine and counting the number of cylinder needles between the spots, remembering that a space also is to be counted at one end just as in counting a screw thread. Frequently, it is possible to find on the stop motion convenient measuring distances which are more than a foot in length and, consequently afford a more accurate result. For scientific purposes one whole turn of the cylinder is taken in order to eliminate the effect of untrueness in the cylinder and dial, but for commercial purposes one foot is generally a sufficient length. The stitches per foot of yarn are desirable for solution of the weight of the fabric per unit of area, square yard or square foot, for solution of the pounds production, and many other useful details.

To start the machine the first consideration should be to have the stitch sufficiently loose so that the machine will start well. After that it may be adjusted according to the requirements. Adjustments may be made to control weight per yard, weight per dozen, appearance, or feel. These adjustments are generally made to a known number of courses per inch or stitches per foot, or by trial, but the rules given elsewhere provide a much more comprehensive method.

There are three places in which the stitch may be adjusted: (1) cylinder stitch cam; (2) dial stitch cam; and (3) dial. The extent and frequency with which any one should be used depend on various considerations among which the following are important:

The dial cannot go lower than the position which surely lets the fabric (bunches included) pass between it and the cylinder. The height to which it may go is greater than the stitch will require. The cylinder stitch must be long enough to enable the loop to clear the needles without tucking or breaking, and should not be so long as to pull the yarn apart at twist. The range of adjustment provided in the machine is greater than that generally allowed by the yarn.

The dial stitch must be long enough to clear itself surely, but is limited by the length of yarn between the dial needles and cylinder needles. In fact the dial cam stitch adjustment is the most limited one of the three; moreover, it can be no longer than is allowed by the cylinder stitch. So, as a rule, the dial stitch is set to clear as surely as possible and close itself as much as possible without unduly straining the yarn. After that the changes are generally made on the cylinder or dial or both, except that to shorten much on the cylinder requires reduction in the dial stitch. To lengthen on the cylinder or to change the position of the dial up or down does not necessitate a change in the dial cam. The cylinder cam does not need to be adjusted for change in the elevation of the dial.

To summarize, the cylinder stitch cam must be set to draw enough yarn for both the cylinder and dial stitch. The dial stitch cam must be set to draw enough to clear the old stitch surely, but not enough to break the new loop. The dial must be far enough away from the cylinder to let the fabric pass through, but may be adjusted farther without necessitating change in either the cylinder or dial cams, until the yarn begins to break or unhook from the cylinder needles, but this is not likely to occur until the fabric is too loose to be useful. The cylinder stitch is adjusted by means of the index eccentric in the cam casing below the point where the cylinder needles draw the yarn down to form the loop. When the screw slot is horizontal and in its highest position, the cam is at its lowest position. Half a turn in either direction gives the entire range of adjustment. The change of adjustment is greatest when the slot is vertical and approaches zero when the slot becomes horizontal. The

dial stitch is adjusted by means of an eccentric like the one in the cam casing on top of the dial cap just after the feed, or by a headless screw in the edge of the dial cap in the same location. Turn the screw clockwise to lengthen the dial stitch. The dial adjustment is effected by means of the nut at the top of the dial stud. The machines with dogs have the nut threaded on the stud so a right-hand turn of the nut elevates the dial, and a left-hand turn depresses it. The stud binding screw must be loosened before each adjustment and tightened after it. When lowering the dial, push the stud down into position after unscrewing the nut, as it will not always drop with its own weight. The dogless machines have capstan nuts threaded on a washer instead of on the stud, so they are turned to the right to depress and to the left to elevate. Use a stiff rod that fits the holes well in order not to bruise them by the slipping out of a scant or flexible wire. Stud binding screws are not used with the dogless attachment, but it is generally necessary to push the stud down after the nut is turned to depress.

Adjusting the Yarn Carrier

The adjustment of the carrier involves four considerations: (1) the heel of the carrier must come as near as possible to the closing cylinder latches without touching them; (2) the bottom of the carrier must come as near as possible to the dial needles without touching them; (3) the inside of the carrier must come as near as possible to the hooks of the cylinder needles without touching them, unless knots catch between the carrier and the check of the needle, in which case the carrier may be moved out a little, provided the hooks surely catch the yarn; (4) The toe of the carrier should be adjusted outward to the position in which it does the least damage to the latches, a position variously estimated from one-eighth to one-fourth inch away from the needles depending on the shape and size of the carrier.

When the carrier is so adjusted, the hooks of the cylinder needles should not be uncovered, cylinder latches should not close inside of the carrier or catch in the yarn hole, and

dial latches should not close under the carrier or before the yarn is under the latch. If these troubles occur, then the shape of the carrier or the location of the hole should be changed to overcome them.

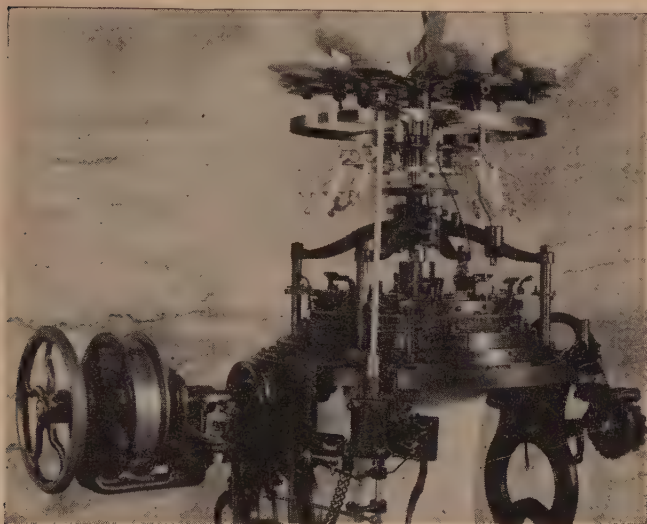


Fig. 50—View of Scott & Williams body machine equipped with Crawford electric stop motion.

Judgment should be used in the second adjustment, especially with machines having dial wing cams, since the height of the dial needles changes according to whether the latches are open or shut, whether the needles are in or out, whether the cloth is on or off, and whether the stitch is loose or tight either owing to adjustment or to a load-up. The carrier should be adjusted to clear the needles under all these conditions.

On following pages are some of the common troubles together with the corresponding causes and remedies. It is assumed that the machines are not in bad order either from excessive use or misuse, and that they are equipped with stop motions. If the machines are in bad order, trouble may arise from so many sources that it is cheaper to have them repaired than to search for remedies. If stop motions are not used, the yarn and winding must be carefully done.

TROUBLE	CAUSE	REMEDY
Stitch dropped from one dial needle but yarn not cut.	Dial latch closing under yarn carrier.	Lower the carrier.
	Dial latch closing near heel of yarn carrier.	Move carrier back as far as possible without interfering with cylinder latches as they close. Carry the yarn lower so that it prevents the closing of the latch. Adjust the cap forward so that the dial needles will not come out so far, unless this interferes with drawing the stitch over the rivet.
Stitch dropped from one cylinder needle, but yarn not cut.	Cylinder needles rising too soon after drawing stitch and so releasing it before the dial needles withdraw to keep the tension on it.	Grind cylinder landing cam so it raises the cylinder needles no faster than the dial needles withdraw.
	Yarn not caught by cylinder needles.	Adjust dial cap forward unless restricted by other requirements.
	Yarn twisting out of cylinder needle hook.	Adjust guard so it will catch. Put tension on yarn. Condition the yarn.
Dial stitch dropped and yarn cut.	Dial needle is too far when yarn is drawing, thus cutting it on sharp edges of saw cut in needle.	Adjust cap back so that yarn is drawn over rivet.
	Lint or a mote clogged in saw cut so that latch cuts itself out of stitch.	Clean out obstruction.
	Latch binding owing to needle being bent or otherwise damaged.	Replace needle.
	Latch closing on one side of hook so letting other side cut stitch.	Replace needle.
	Dial needle drawing in too far, thus cutting stitch on edge of sinker or breaking it.	Adjust dial-stitch cam outward.
	Stitch so tight that it fails to clear and breaks when needle comes out.	Loosen stitch. Use lighter yarn or coarser cut.

TROUBLE	CAUSE	REMEDY
Cylinder stitch dropped and yarn cut.	Latch swinging to one side and catching on dial needle, thus breaking out of the stitch. May result from saw cut being out of line with the butt, the latch being loose, the latch being bent, the needle too loose in the slot.	Replace needle.
	Latch closing on yarn carrier.	Adjust yarn carrier forward.
	Yarn cutting between cylinder and dial needle.	Adjust dial so that the two sets of needles will not interfere.
	Stitch so long that the needle breaks the yarn in drawing it.	Use yarn suitable to the stitch, or readjust latter.
■		
Vertical line of big stitches.	Edge of spoon landing on hook, thus preventing latches closing completely.	Replace needle.
■		
Vertical lines or lines of dial tucks.	Dial latches scored by yarn carrier (on machines with tucking or welting attachment).	Raise yarn carrier so that dial needle with closed latch will pass beneath under all conditions, and replace damaged needles.
Needles loading up all around.	Slack take-up. Due to (1) Insufficient weight.	Add front weight or adjust take-up weight-hanger-rod outward. Take off back weight or adjust weight-hanger-rod inward.
	(2) Inoperation of take-up stop motion.	Adjust stop-off chain-connecting take-up and knock-off handle so that power will knock off before take-up rests on leg base.
	(3) Take-up pulley, gear, or collar loose.	Tighten loose part.
	(4) Take-up gummed.	Clean and oil take-up.
	Cloth held between dial and cylinder.	Elevate dial.
	Yarn too heavy.	Use lighter yarn or coarser cut.
	Stitch too tight.	Loosen stitch.

TROUBLE	CAUSE	REMEDY
Fabric pulling off needles.	Dial needles scored all around by low carrier, and cutting stitches.	Raise carrier and replace damaged needles.
	Stitch far too tight.	Loosen stitch.
	Take-up tension too severe.	Take off front weights or adjust weight - hanger - rod inward. Add back weights or adjust weight-hanger-rod outward.
One or more cylinder stitches dropped in line with dogs.	Dogs holding fabric back so that cylinder stitches unhook from cylinder needles.	Increase take-up tension. Grind landing cam down if allowable.
Cut, or drop, with a seed, knot, slub, or bunch in it.	The seed, knot, slub, or bunch.	Keep these obstructions out as much as possible, by adjustment of the stop motion and by keeping the machine free from collections of lint. See that the freest possible passage is allowed for those that do go into the machine. Knots and bunches may catch between the yarn carrier and the cheek of the cylinder needle, or the dial needle may be out of its mid - position between the cylinder needles, so that the obstruction is held between cylinder and dial needle.
Press off without stop motion tripping.	Yarn parting owing to a pull between the needles and the sweep wire.	Modify eye.
	(1) An eye clogged with lint owing to roughness, to being too long, to being too small.	Use porcelain eye.
	(2) Knot catching on sharp edge of eye.	Round edge.
	(3) Knot catching between yarn carrier and cheek of needle.	Use porcelain eye. Move carrier out, if yarn is not likely to drop.
	Lint holding feeler finger.	Drill yarn hole higher.
	Stop motions improperly threaded.	Clean stop motion regularly. Use caution in threading.

Needles per Inch for Different Diameters and Numbers of Cylinder Slots*

(The nominal diameter is that of the cam surface of the cylinder. The diameter from back to back of needles is .3075 less than the nominal diameter.)

Nominal dia.	Circum.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
2	5.317	3.761	4.137	4.514	4.890	5.266	5.642	6.018	6.394	6.770	7.146	7.522	7.899	8.275	8.651	9.028
1/4	6.103	3.277	3.605	3.933	4.260	4.588	4.916	5.243	5.571	5.899	6.226	6.554	6.882	7.210	7.538	7.865
1/2	6.888	2.904	3.194	3.484	3.775	4.065	4.355	4.646	4.936	5.226	5.517	5.807	6.098	6.388	6.678	6.969
3/4	7.674	2.606	2.867	3.128	3.388	3.649	3.909	4.170	4.431	4.691	4.952	5.212	5.473	5.734	5.994	6.255
3	8.460	2.364	2.600	2.837	3.073	3.310	3.546	3.783	4.019	4.255	4.492	4.728	4.965	5.201	5.437	5.674
1/4	9.244	2.164	2.380	2.596	2.813	3.029	3.245	3.462	3.678	3.894	4.111	4.327	4.544	4.760	4.976	5.192
1/2	10.030	....	2.193	2.393	2.592	2.792	2.991	3.190	3.390	3.589	3.789	3.988	4.187	4.387	4.586	4.786
3/4	10.815	....	2.034	2.219	2.404	2.589	2.774	2.959	3.144	3.329	3.514	3.698	3.883	4.068	4.253	4.438
4	11.600	....	....	2.069	2.241	2.414	2.586	2.758	2.931	3.103	3.275	3.448	3.621	3.793	3.965	4.138
1/4	12.386	....	....	....	2.099	2.260	2.422	2.583	2.745	2.906	3.068	3.220	3.391	3.552	3.713	3.875
1/2	13.171	....	....	....	....	2.126	2.277	2.429	2.581	2.733	2.885	3.037	3.189	3.340	3.492	3.644
3/4	13.957	....	....	....	....	....	2.149	2.293	2.436	2.579	2.722	2.866	3.009	3.152	3.295	3.439
5	14.742	....	....	....	....	....	....	2.170	2.306	2.442	2.578	2.713	2.849	2.984	3.120	3.256
1/4	15.528	....	....	....	....	....	....	2.060	2.189	2.318	2.447	2.576	2.705	2.834	2.975	3.091
1/2	16.313	....	....	....	....	....	....	....	2.084	2.207	2.329	2.452	2.575	2.697	2.820	2.942
3/4	17.100	....	....	....	....	....	....	....	....	2.105	2.222	2.339	2.456	2.573	2.690	2.807
6	17.883	....	....	....	....	....	....	....	....	....	2.125	2.237	2.348	2.460	2.572	2.684
1/4	18.670	....	....	....	....	....	....	....	....	....	....	2.142	2.250	2.357	2.464	2.571
1/2	19.455	....	....	....	....	....	....	....	....	....	....	2.056	2.159	2.261	2.364	2.467
3/4	20.240	....	....	....	....	....	....	....	....	....	....	....	2.075	2.174	2.273	2.371

*From *Science of Knitting*, Tompkins.

Needles per Inch for Different Diameters and Numbers of Cylinder Slots*

The diameter from back to back of needles is .3075 less than the nominal diameter. The diameter from back to back of needles is .3075 less than the nominal diameter.)

Nominal dia.	Circum.	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
2	5.317	9.403	9.780	10.160	10.530	10.910	11.280	11.660	12.040	12.410	12.790	13.160	13.540	13.920	14.290	.....
1/4	6.103	8.193	8.520	8.848	9.176	9.504	9.832	10.160	10.490	10.810	11.140	11.470	11.800	12.130	12.450	12.780
1/2	6.888	7.259	7.550	7.840	8.130	8.420	8.711	9.002	9.292	9.582	9.872	10.160	10.450	10.740	11.030	11.320
3/4	7.674	6.516	6.776	7.036	7.298	7.558	7.819	8.080	8.340	8.601	8.862	9.122	9.382	9.644	9.904	10.160
3	8.460	5.910	6.148	6.383	6.620	6.856	7.092	7.328	7.565	7.802	8.038	8.274	8.510	8.747	8.983	9.220
1/4	9.244	5.409	5.625	5.841	6.058	6.274	6.491	6.707	6.923	7.140	7.356	7.572	7.789	8.005	8.221	8.438
1/2	10.030	4.985	5.184	5.384	5.583	5.782	5.982	6.182	6.381	6.580	6.780	6.979	7.178	7.378	7.577	7.777
3/4	10.815	4.623	4.808	4.993	5.178	5.363	5.548	5.732	5.917	6.102	6.287	6.472	6.657	6.842	7.027	7.212
4	11.600	4.310	4.482	4.655	4.827	5.000	5.172	5.344	5.517	5.689	5.861	6.034	6.206	6.379	6.551	6.724
1/4	12.386	4.037	4.198	4.359	4.521	4.682	4.844	5.005	5.166	5.328	5.490	5.651	5.812	5.974	6.136	6.297
1/2	13.171	3.796	3.948	4.100	4.251	4.403	4.555	4.707	4.859	5.010	5.162	5.314	5.466	5.618	5.770	5.922
3/4	13.957	3.582	3.725	3.869	4.012	4.155	4.298	4.442	4.585	4.728	4.872	5.015	5.158	5.302	5.445	5.588
5	14.742	3.391	3.527	3.663	3.798	3.934	4.070	4.205	4.341	4.477	4.612	4.748	4.884	5.020	5.155	5.290
1/4	15.528	3.220	3.348	3.477	3.606	3.735	3.864	3.992	4.121	4.250	4.379	4.508	4.636	4.765	4.894	5.023
1/2	16.313	3.065	3.187	3.310	3.433	3.555	3.678	3.800	3.923	4.045	4.168	4.291	4.413	4.536	4.658	4.781
3/4	17.100	2.924	3.041	3.158	3.275	3.392	3.509	3.626	3.742	3.860	3.976	4.094	4.210	4.327	4.444	4.561
6	17.883	2.796	2.908	3.019	3.131	3.243	3.355	3.467	3.579	3.690	3.802	3.914	4.026	4.138	4.250	4.362
1/4	18.670	2.678	2.785	2.892	2.999	3.106	3.214	3.320	3.428	3.535	3.642	3.749	3.856	3.963	4.070	4.177
1/2	19.455	2.570	2.673	2.775	2.878	2.981	3.084	3.187	3.289	3.392	3.495	3.598	3.700	3.803	3.906	4.009
3/4	20.240	2.470	2.569	2.668	2.767	2.866	2.964	3.063	3.162	3.261	3.360	3.459	3.557	3.656	3.755	3.854

*From Science of Knitting, Tompkins.

Needles per Inch for Different Diameters and Numbers of Cylinder Slots*

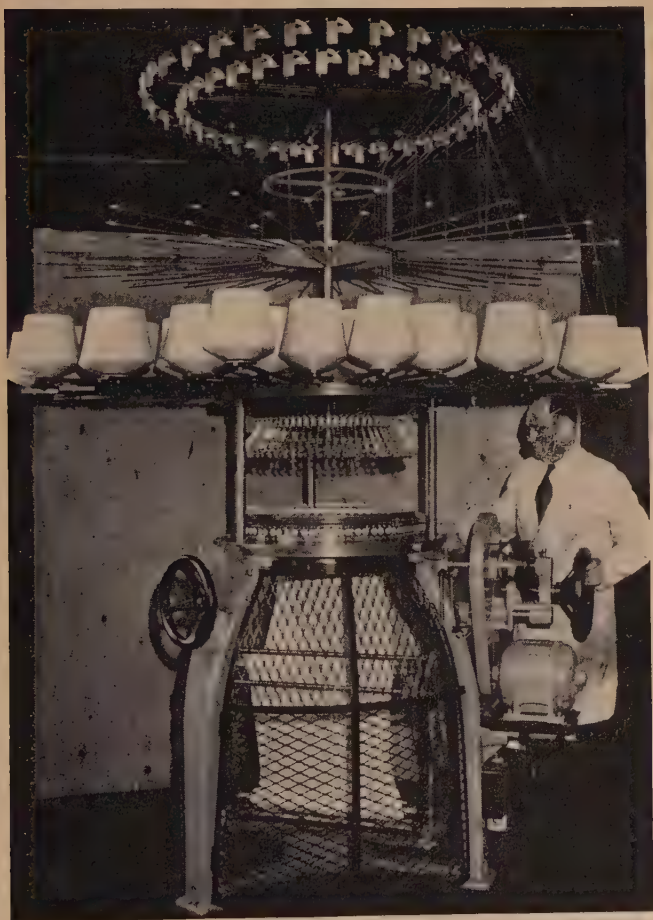
(The nominal diameter is that of the cam surface of the cylinder. (The nominal diameter is that of the cam surface of the cylinder. nominal diameter.)

Nominal dia.	Circum.	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108
2	5.317	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1/4	6.103	13.110	13.440	13.760	14.090	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1/2	6.888	11.610	11.900	12.200	12.490	12.790	13.070	13.360	13.650	13.940	14.230	.....	.....	.....	.....	.....
3/4	7.674	10.420	10.690	10.950	11.210	11.470	11.730	11.990	12.250	12.510	12.770	13.030	13.290	13.550	13.810	14.070
3	8.460	9.456	9.693	9.930	10.170	10.400	10.640	10.870	11.110	11.350	11.560	11.820	12.060	12.290	12.530	12.770
1/4	9.244	8.654	8.870	9.088	9.303	9.520	9.736	9.952	10.170	10.380	10.600	10.820	11.030	11.250	11.470	11.680
1/2	10.030	7.976	8.176	8.375	8.574	8.774	8.973	9.173	9.372	9.572	9.771	9.970	10.170	10.370	10.570	10.770
3/4	10.815	7.397	7.582	7.767	7.952	8.137	8.321	8.506	8.692	8.876	9.061	9.246	9.431	9.616	9.802	9.986
4	11.600	6.896	7.068	7.241	7.413	7.586	7.758	7.930	8.104	8.275	8.448	8.620	8.793	8.965	9.138	9.310
1/4	12.386	6.458	6.620	6.782	6.943	7.104	7.266	7.427	7.589	7.750	7.912	8.073	8.235	8.396	8.558	8.719
1/2	13.171	6.074	6.225	6.377	6.529	6.681	6.832	6.984	7.136	7.288	7.440	7.592	7.744	7.896	8.048	8.200
3/4	13.957	5.732	5.874	6.018	6.162	6.305	6.448	6.591	6.735	6.878	7.021	7.164	7.308	7.451	7.595	7.738
5	14.742	5.426	5.562	5.698	5.833	5.969	6.105	6.240	6.376	6.511	6.647	6.783	6.919	7.054	7.190	7.326
1/4	15.528	5.152	5.280	5.409	5.538	5.667	5.796	5.924	6.053	6.182	6.311	6.440	6.568	6.697	6.826	6.955
1/2	16.313	4.904	5.026	5.149	5.271	5.394	5.516	5.640	5.762	5.884	6.007	6.130	6.252	6.375	6.498	6.620
3/4	17.100	4.678	4.795	4.912	5.029	5.146	5.261	5.380	5.497	5.614	5.731	5.848	5.965	6.082	6.199	6.316
6	17.883	4.473	4.585	4.697	4.809	4.921	5.032	5.144	5.256	5.368	5.480	5.592	5.704	5.815	5.927	6.039
1/4	18.670	4.285	4.392	4.499	4.606	4.713	4.820	4.928	5.035	5.142	5.249	5.356	5.463	5.570	5.678	5.785
1/2	19.455	4.112	4.214	4.318	4.420	4.523	4.626	4.728	4.832	4.934	5.037	5.140	5.243	5.346	5.448	5.551
3/4	20.240	3.952	4.051	4.150	4.249	4.348	4.447	4.545	4.644	4.743	4.842	4.941	5.040	5.138	5.237	5.336

*From *Science of Knitting*, Tompkins.

Chapter V. Plain Jersey Fabric Production With Multiple-Feed Latch Needle Machines

THE Supreme Model MJ Machine is a circular knitting machine designed for the rapid production of cloth for



Shown above is the Model MJ 64-feed circular jersey knitting machine built by Supreme Knitting Machine Co.

polo shirts, underwear, linings, and similar jersey apparel. It is distinguished from the conventional knitting machine by its tripod construction, the revolving take-up and cloth roll-up, and the micromatic stitch control.

The relay starting box is the machine's "on" and "off" switch, and is mounted on the drive leg beneath the motor. It is equipped with thermal overload safety devices which permit only normal machine operation. Should the motor become overloaded or overheated, the thermal overload switch will cut off the current, and the motor cannot be started again until the reset button has been pressed. Unless otherwise specified, the machine is supplied with a 220/440-volt motor which is set to operate on 220-volt, three-phase, 60-cycle alternating current. It is capable of continuous operation with a minimum of attention. The motor platform is mounted on an eccentric shaft which permits adjustment of the tension of the silent drive chain.

The adjustable multi-disc clutch is recessed into the large silent chain sprocket wheel, and permits almost instantaneous starting and stopping of the machine without stopping the motor. The double starting handle is located on both sides of the motor drive system. In the horizontal position, it engages the clutch and starts the machine. In the vertical position it disengages the clutch and stops it. The stop button, on the far side of the outer ring, may be used when the operator is not within reach of the starting handles. It disengages the clutch, but the motor will continue to run.

There are three hand-wheels 5, Fig. 51, equally spaced around the machine to allow the operator to turn the machine manually. They are geared to permit either fractional or large movements of the cylinder. Backward rotation is impossible. When the machine is power driven they are disengaged automatically and remain idle. To engage any one of them when the machine is not power driven, the operator pushes the hand wheel slightly forward. Each is an independent unit and one is always within reach of the operator.

The gears, sprocket wheels, and drive chains of the

motor and hand drive systems are enclosed by safety guards. If these are removed for service or adjustments, they should

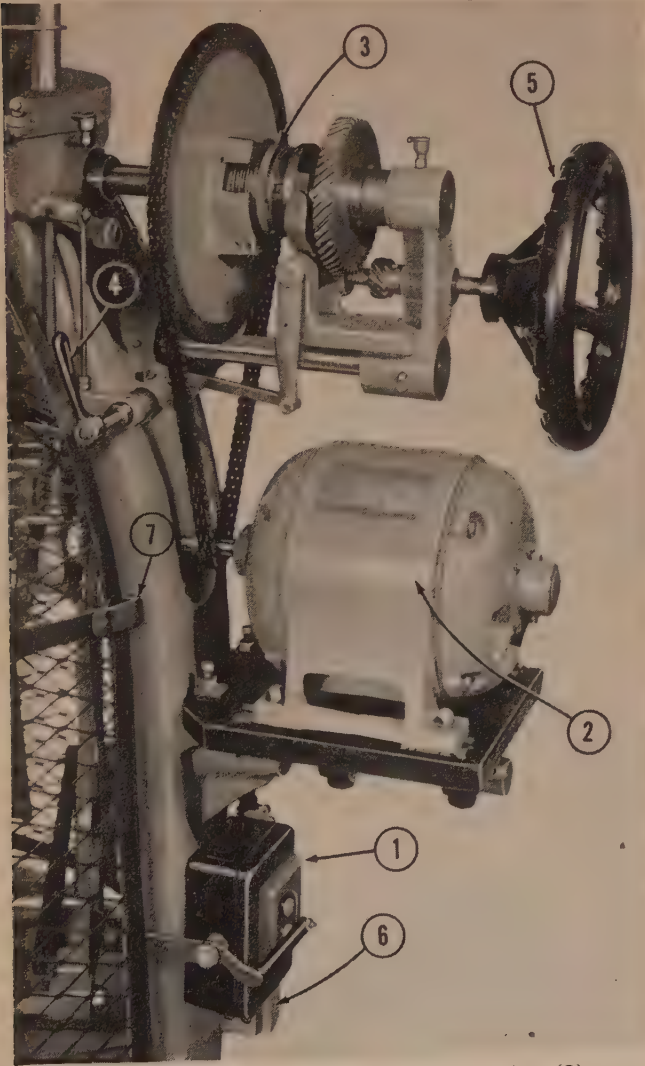


Fig. 51—Section of drive leg showing (1) relay starting box, (2) motor, (3) clutch, (4) starting handle, (5) handwheel, (6) transformer and (7) gate latch.

be replaced before operating the machine. The top stop motion, Fig. 52 or 53, located on the top of the stop motion supporting shaft, is an electrical device activated by the yarn threads. It disengages the clutch and stops the ma-



Fig. 52—Crawford top electric stop motion.



Fig. 53—Wesco top electric stop motion.



Fig. 54—Crawford bottom electric stop motion.

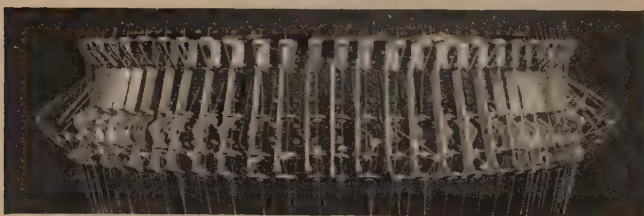


Fig. 55—Wesco bottom electric stop motion.

chine when there are yarn thread defects, such as a break in the yarn, coming to the end of a yarn cone, or large slubs or knots in yarn. For ease in detecting the point of yarn trouble, the top stop-motion is divided into quarters with a locating lamp for each quarter. The bottom stop motion, Fig. 54 or 55, is an auxiliary electrical device activated by the yarn threads. Its function and operation are similar to the top stop motion but it is located beneath the yarn rack.

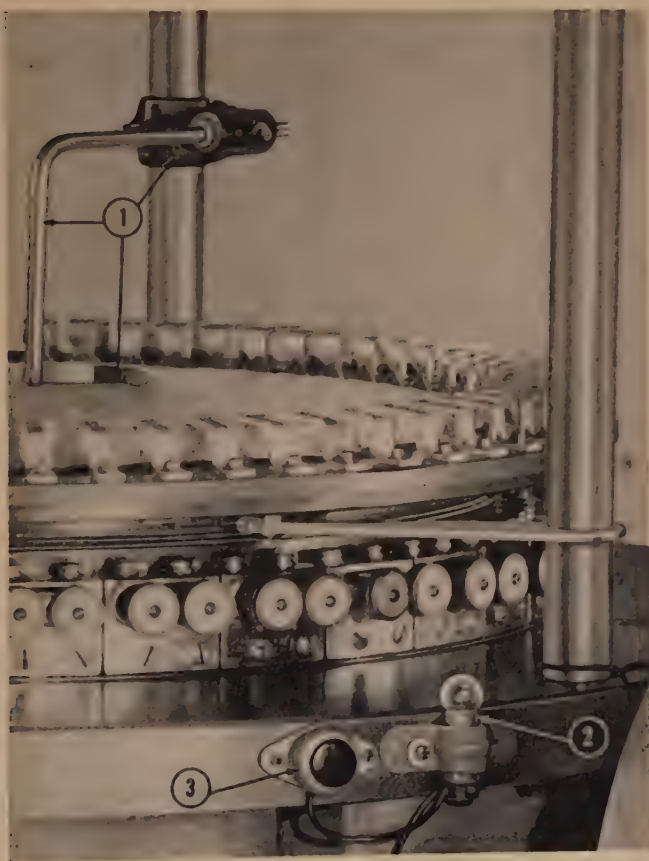


Fig. 56—Section of knitting elements system, showing (1) cloth fall-out detector, (2) warning lamp and (3) stop button.

The cloth fall-out detector is an electrical device mounted on any yarn rack post with its detector spring touching the knitting surface. Should any portion of the cloth fall off the needles, the spring will make contact with the sinkers, closing an electrical circuit. This disengages the clutch and stops the machine. The warning lamp 2, Fig. 56, located on the outer ring, lights when the top or bottom stop motions or the fall-out detector make contact, and the machine stops. It will stay on until the defect has been remedied, but will go out momentarily when the stop motion button is depressed.

The stop motion button 3, Fig. 56, on the outer ring near the drive leg is used only when the machine has stopped and the warning lamp is lit. It is then employed in conjunction with the four small locating lamps on the top stop motion to determine whether the contact is being made in either the top or bottom stop motions, or in the cloth fall-out detector. Unless otherwise specified, the machine is equipped with a 220-volt primary, 16-volt secondary transformer 6, Fig. 51, to supply current for the two stop-motions, the cloth fall-out detector, the electric latch, and the warning light. It is mounted either on the relay starting box or on the drive leg below the relay starting box.

The electric latch is a control mechanism located on the inside of the drive leg. When electrically activated by either of the stop motions, or the cloth fall-out detector, it releases a mechanical linkage that disengages the clutch and stops the machine. At the same time, it throws the starting handle into the vertical or stop position. The linkage mechanism is reset automatically when the starting handle is moved to the horizontal or start position. The yarn rack assembly with its cone supports is a stationary vibration-free support for the yarn cones. Its design prevents the cones from tipping.

The guide rod rack assembly, located on the stop motion supporting shaft above the yarn rack, guides the yarn threads in a straight line from the cones to the top stop motion. The porcelain guides prevent large slubs, knots, and other foreign matter from passing through to the knit-

ting elements. The hole through which the thread will pass in the three-hole porcelain should be governed by the yarn size. The yarn guide rings, on the stop motion supporting shaft, guide the yarn threads in a straight path from the top stop motion to the bottom stop motion. They also prevent entangling. The cloth spreader is a revolving yoke-shaped device located at the bottom of the stop motion supporting shaft. It maintains the fabric at the desired width as it passes from the knitting elements to the take-up rollers. It is adjustable for height and width. The outer ring serves as a support for the entire knitting elements system and is a major portion of the machine frame. The three legs and the yarn rack posts are fastened directly to it.

The cylinder gear ring rotates in a recess in the outer ring and is powered either by the motor drive or the hand drive. All moving parts of the knitting elements system derive their motion from the cylinder gear ring. The cam retaining ring is a stationary ring whose inner circumference consists of a raised wall. To the inside of this wall are fastened the needle raising cams, while to the outside are bolted the sections with their stitch cams and micromatic controls. The completed cam assembly forms the raceway for the needle butts and thus controls the vertical motion of the knitting needles.

The inserted wall cylinder which rotates inside the cam retaining ring is fastened to the cylinder gear ring. It houses the sinkers and needles and is made up of the following components: the cylinder body, the cylinder inserts, the insert retaining ring, the cylinder springs, the sinker rest ring, and the sinker dial.

The cylinder body is a forged steel ring accurately slotted to receive the cylinder inserts. When inserted in the slots of the cylinder body, these inserts form the slots in which the knitting needles move. The inserts are locked in place by the insert retaining ring on the bottom of the cylinder body, but may be readily removed for replacement. The needles, with butts facing outward, are inserted into the slots formed by the cylinder inserts and held in place by

the cylinder springs. The cylinder springs snap into place and out of the way in a circumferential groove.

The slotted sinker rest ring is bolted to the top of the cylinder body. The slotted sinker dial rests on the outside of the cylinder on a ledge formed by a protrusion in the cylinder inserts, and is locked to the cylinder. It is aligned with the sinker rest ring so that the sinkers, when inserted, can move back and forth freely.

The sinker cam ring contains the interlocked sinker cams that control the motion of the sinkers. It is placed over and rides in the sinker channel. It is held stationary by links from the yarn rack posts. It is also held in place vertically by clamps that fit under but are not fastened to the sinker dial. This "floating" action of the sinker cam ring is a definite advantage since it affords maximum control of the sinkers with minimum wear. It has a removable gate to permit easy replacement of individual sinkers.

The feeder carrier ring is stationary and is fitted over and fastened to the sinker cam ring. It carries the multiple feed yarn carriers that guide the thread from the bottom stop-motion to the knitting needle. The take-up table, located in the center of the base leg tie, serves as a foundation for the take-up and cloth roll-up. It houses the gears that power the rollers of the take-up and cloth roll-up, and also the Timken roller bearings upon which the take-up and cloth roll-up revolve.

The take-up is revolved by driving brackets from the cylinder gear ring. It is pivoted and counterbalanced by a weighted bar to maintain uniform cloth tension automatically at the knitting elements. Since the cloth is interwound and gripped positively between the two take-up rollers as it is drawn through, the increasing weight and size of the cloth roll below does not affect the cloth tension at the knitting elements. The take-up is equipped with a worm disengaging lever so that the power drive to the take-up rollers may be disconnected. This allows the operator to revolve the take-up rollers by hand when interwinding a new run of cloth.

The cloth roll-up is located above the take-up table and

below the take-up. Its action is independent of the take-up. It is equipped with two pressure levers to assure compact, uniform cloth rolls. The cloth rolls are easily accessible and removable. The revolving take-up and cloth roll-up are guarded by three gates. Two are stationary and the third is hinged. The stationary side gates may be removed by lifting the locking pin that passes through the outer ring, and then lifting the gate out. The hinged gate may be opened by merely lifting the gate latch 1, Fig. 51.

The hinged gate is supplied with a mechanical safety device designed to stop both the motor and the machine when the hinged gate is opened. This allows the operator to remove finished cloth rolls with safety. When the gate is opened, a mechanical linkage operates the "stop" button on the relay starting box, and stops the motor. The gate should be closed again before pressing the "on" button to start the motor.

Machine Adjustments

To Use the Stop Motion Button: The stop motion button, on the outer ring, is used to indicate the point of contact when the machine has stopped and the warning lamp is on. The steps in its use are as follows: (a) Press the stop motion button and look at the four small locating lamps on the top stop motion. If one lights, the contact will be found in one of the stop motion ends in the area covered by that lamp. If none of the lamps light, the point of contact will be either in the bottom stop motion or in the cloth fall-out detector. (b) Visually determine whether the point of contact is in the bottom stop motion or in the cloth fall-out detector. (c) When the circuit has been cleared, the warning lamp will go out and the machine may then be started.

Interwinding the Cloth Through the Take-up: Knit until the fabric reaches approximately 18 inches below the cloth spreader. Stop the machine with the take-up rollers parallel to the hinged gate and with the pressure levers facing the operator. Open the gate and disengage the worm by lowering the worm disengaging lever. The take-up

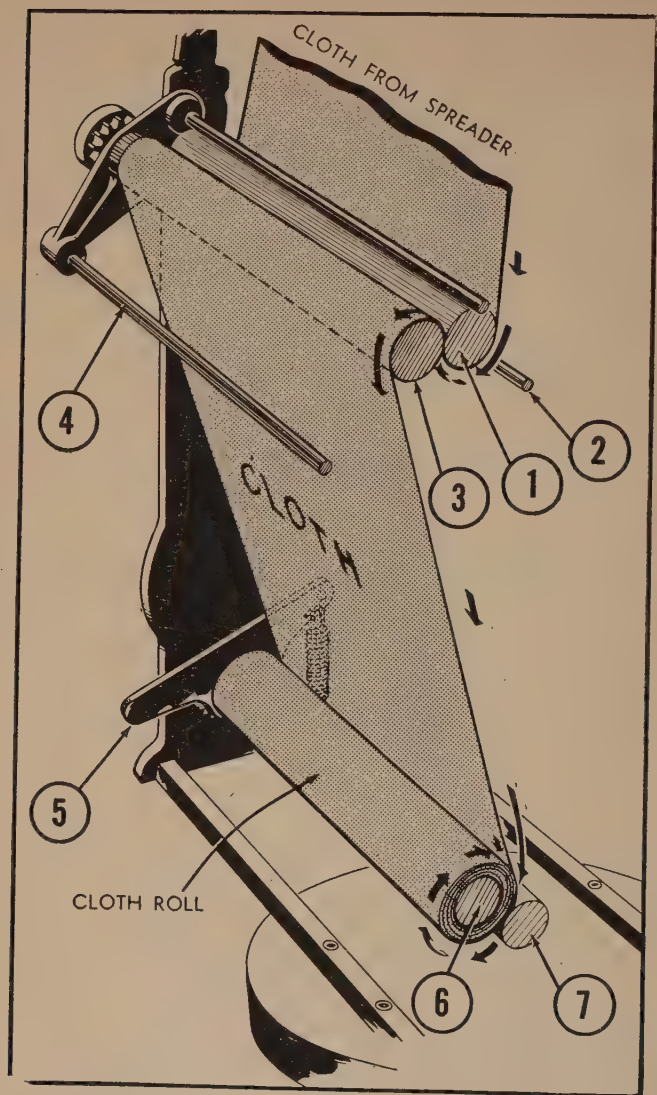


Fig. 57—Path of cloth through take-up and cloth roll-up.

rollers 1, Fig. 57, may now be revolved by hand. Pass the cloth between take-up roller (driven) 1 and the take-

up wall tie rod 2. Now bring it under the take-up roller (driven) and up between the drive take-up roller 3 and the take-up roller (driven). Revolve the rollers by hand to feed it through. Bring it over the drive take-up roller and let it hang down between the drive take-up roller and the bottom spacer shaft for the take-up brackets 4. Stretch the cloth to the proper width and lift the worm disengaging lever so that the worm re-engages the worm gear. The rollers may have to be revolved by hand slightly if the teeth do not mesh. Close the hinged gate, press the "on" button and start the machine.

Starting a Cloth Roll: Knit until fabric hanging in the take-up is approximately six inches longer than the distance from the take-up to the cloth roll-up. Stop the machine with the cloth roll-up parallel to the hinged gate and with the pressure levers 5, Fig. 57, facing the operator. Open the gate and lift the elevating cloth roller (smooth one) 6 slightly and pass the cloth between it and the friction drive roller 7 (bottom knurled one). Pull the cloth through, stretch it to the desired width, bring it around the roller, tuck the end between the cloth and the roller, and wind it up tightly. Close the hinged gate, push the "on" button and start the machine.

When the cloth roll weighs about 40 pounds (weight that is recommended by most dyehouses) and is approximately 14 inches in diameter, it may be removed. Stop the machine with the cloth roll-up parallel to the hinged gate and with the pressure levers facing the operator, and open the gate. Lift the two pressure levers simultaneously and allow roll wound about the elevating cloth roller to drop onto the floor. Cut the fabric so that sufficient material will remain hanging from the take-up to start a new cloth roll.

There is a small cross-hole drilled in the elevating cloth roller. Stand the cloth roll up so that this cross-hole is towards the ceiling. Now lift the elevating cloth roller out of the center of the cloth roll. If this is difficult, pass a small steel rod through the cross-hole, grip it with both hands, turn it to loosen, and lift the elevating cloth roller out. Remove the steel rod. Then lift the two pressure

levers and replace the elevating cloth roller on the top of friction drive roller. Hook it securely in place under each pressure lever. Start the cloth roll as previously described. Close the gate, push the *on* button and start the machine.

Adjusting the Take-up Rollers: Insert a separate yard of cloth in between the rollers. Engage the worm in the worm gear. Loosen two nuts holding the off-set weight bar. Turn the screws in the take-up bracket clockwise to tighten rollers; counter-clockwise to loosen. When adjusted properly, the rollers will not cut the fabric and a strong hand pull will be required to slip the cloth through the stationary rollers. Tighten locknuts.

Adjusting Weights on Take-up: The take-up is pivoted and counter-balanced by a weighted bar to automatically maintain uniform cloth tension. It is easily adjusted to the strength of the yarn and the tightness of fabric desired. To adjust it as a "light" take-up (an advantage when knitting with fine yarn counts or tender soft yarn), loosen and remove weights on the weight bar until the desired effect is achieved.

To Adjust the Cloth Fall-out Detector: To adjust the cloth fall-out detector vertically, loosen the screw that holds the mounting clamp to the yarn rack post and set the bottom edge of the detector spring one-quarter of an inch below the top of the sinkers. The flat middle portion of the detector spring should rest flat against the cloth on the most forward sinkers with light pressure. To adjust the pressure, loosen the screw holding the insulated bushing and slide the detector rod in or out. Tighten all screws.

To Replace Individual Sinkers (Figs. 58, 59): Turn the machine by hand until the defective sinker is directly under the sinker removing gate which is inserted in the sinker cam ring. Remove the multiple feed yarn carrier over the sinker removing gate, remove the two side screws in the gate and lift the gate out by the center screw. Use tweezers or long-nosed pliers to extract the defective sinker and to replace it with a new one. Make sure gate seat is clean before screwing down firmly in place.

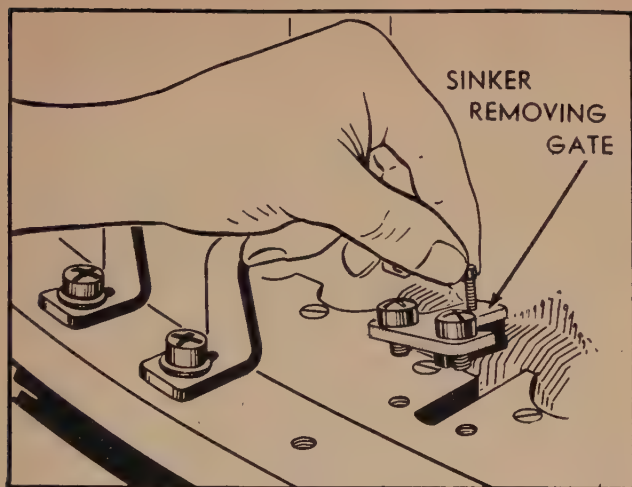


Fig. 58—Removing sinker removing gate.

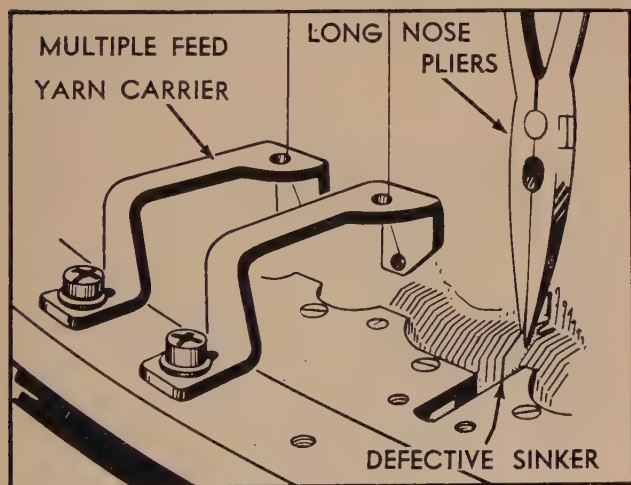


Fig. 59—Removing defective sinker.

To Replace Individual Needles: Turn the machine by hand until the defective needle is at its lowest position. Remove the proper section, and using long nosed pliers, grab the butt and lift the needle up and then out. Reverse the

process when inserting new needle, taking care not to bend the needle. Shift the needle butt into the empty space in the needle butt pattern formed by the cams and replace the section.

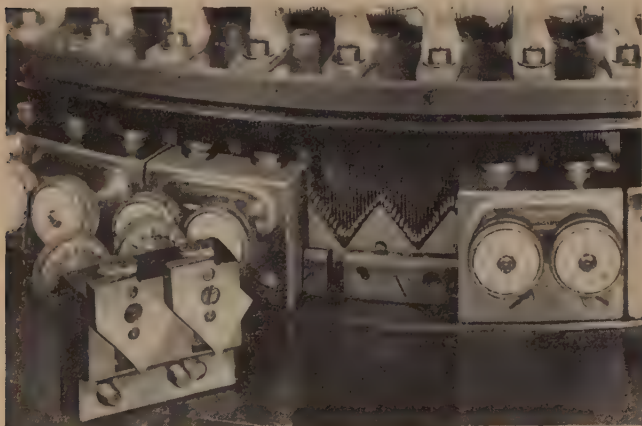


Fig. 60—Portion of knitting elements system with duplex section removed for replacement of defective needle.

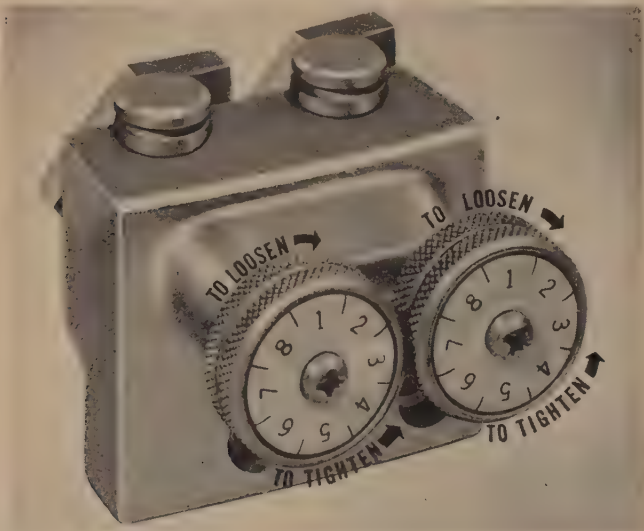


Fig. 61—Duplex section with micromatic stitch control showing direction for tightening or loosening stitches.

Micromatic Stitch Control: The micromatic stitch control (Figs. 61, 62) enables the operator to tighten or loosen the stitches easily and uniformly. To loosen the stitch, turn stitch setting screws clockwise, turning all screws to the same number. To tighten, turn counter-clockwise. Tightening or loosening should be done in degrees to prevent forming holes in fabric and to prevent fabric from becoming imperfect. Count the number of stitches in the swatch with a stitch glass.



Fig. 62—Cam raceway for needle butts controlled by micromatic stitch controls.

To Check Stitch Uniformity (Figs. 63, 64): Mark the top of one sinker with red pencil and put a red mark on sinker cam ring directly in line with this sinker. Mark threads on the top of the top yarn guide ring as follows: Pulling upwards gently, take the slack out of the thread, rub the forefinger on lipstick and roll the thread between the thumb and forefinger while resting the fingers on top of the ring. This will leave a red spot on the thread. Repeat with all threads. Rotate the machine by power until the lowest red spot on any thread touches the multiple feed yarn carrier. If the stitch is uniform, all spots on threads will only vary in height within a one-inch range and no further adjustment is necessary.

If the spots vary above the one-inch range in height, adjust the stitch setting screws as follows: Observe the general level on which the majority of the red spots on the

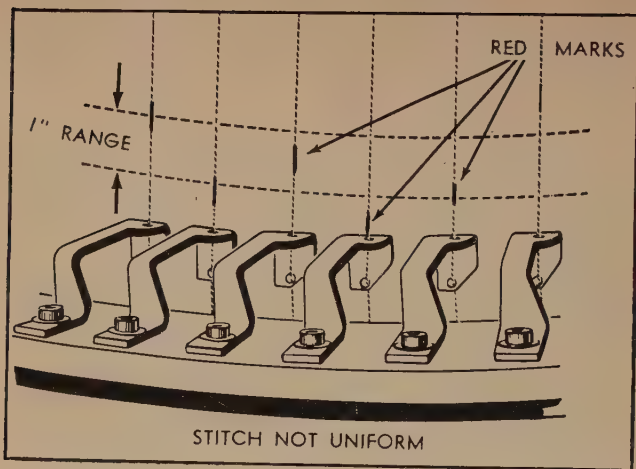


Fig. 63—Checking stitch uniformity (stitch not uniform).

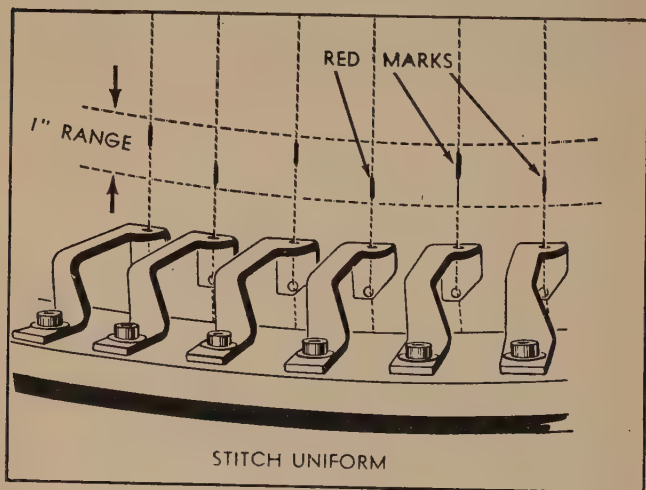


Fig. 64—Checking stitch uniformity (stitch uniform).

threads are located. Spots that are above this level indicate the stitch setting screws to be turned clockwise; spots that are below indicate the screws to be turned counter-clockwise. (On a 20-cut machine, one space, i. e., one click, on the dial is equal to approximately one inch in height on

the threads.) Repeat the process until the stitch is uniform, stopping the red-marked sinker opposite the red mark on the sinker cam ring each time.

To Realign Stitch Setting Screw Dials: Set the fabric for uniform stitch. Then with screwdriver, loosen small Phillips head screw in the center of each dial, revolve the dial in its recess until the number 1 is up, and then tighten screw. It will be necessary to hold the knurled stitch setting screw during this operation. When completed, the stitch and dial settings are all uniform.

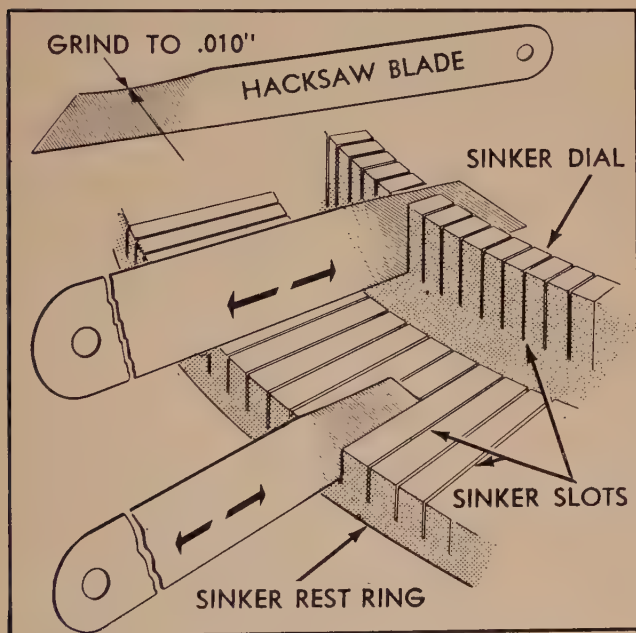


Fig. 65—Cleaning sinker slots.

To Clean Sinker Slots (Fig. 65): Remove the four screws holding the feeder carrier ring to the sinker cam ring. Horizontally lift the feeder carrier ring with yarn ends still in multiple feed yarn carriers and tie the ring securely to the bottom of the yarn rack. Break the yarn threads several inches above the needles and tie the upper ends all in one

knot. Drop the lower end around needles. Loosen the cloth spreader shaft and gently drop the cloth spreader into the cloth web. Remove the nuts on the three drag link studs and allow the drag links to drop down. Remove sinker ring clamps and shims and take sinker cam ring out of machine. Remove all sinkers, and with compressed air, blow slots in sinker dial and rest ring clean. Scrape slots in both rings clean with thin-bladed tool fashioned from a hacksaw blade. Blow clean spray slots with light film of oil. Wash old sinkers in kerosene and replace in slots. Make sure each sinker moves freely. Replace, reassemble, and align sinker cam ring and feeder carrier ring.

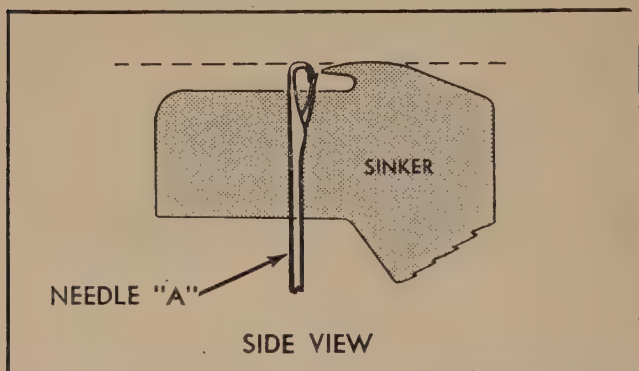


Fig. 66—Locating Needle A (side view showing height with relation to sinker).

To Adjust Sinker Cam Ring (Figs. 66, 67): To adjust the sinker cam ring to the proper knitting position, loosen the nuts on the three drag link studs. This will allow the ring to turn within the limits of the elongated slots in the drag links. Select a needle that is being drawn down by the stitch cam and that is level with the extreme top of the sinkers. Shift the ring circumferentially by hand until that needle is in line with the center of the V formed by a sinker cam. For future reference, we will call this needle A. Tighten the drag link stud nuts. The sinker cam ring is held in place vertically by clamps that are fitted under but not fastened to the sinker dial. There should be ap-

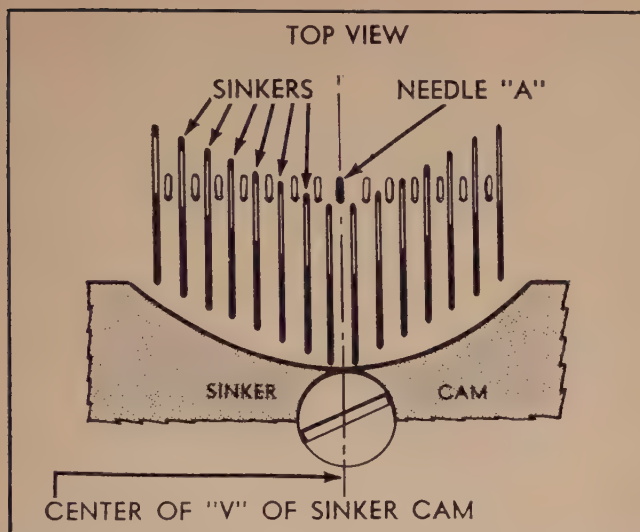


Fig. 67—Locating Needle A (top view showing position with relation to sinker cams).

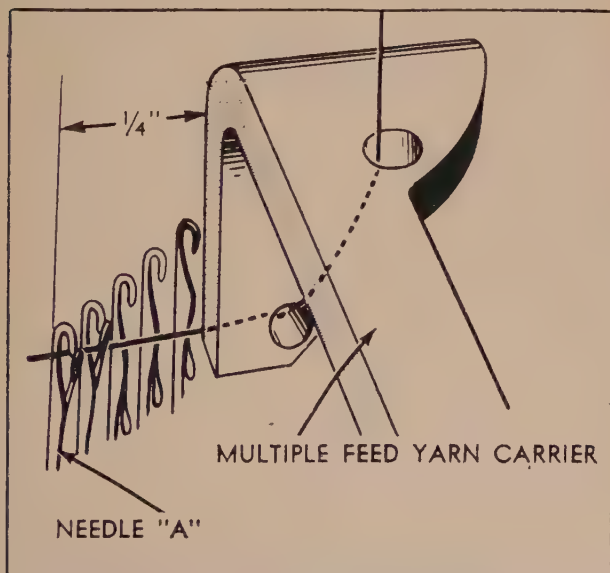


Fig. 68—Multiple-feed yarn carrier position with relation to Needle A.

proximately .002 of an inch clearance between the clamps and the sinker dial which may be obtained by placing or removing shims under the clamps.

Adjustment of the Multiple Feed Yarn Carriers (Fig. 68): Check that the screws that lock the feeder carrier ring to the sinker cam ring are in the center of their slots. The multiple feed yarn carrier also has an elongated locking slot to allow adjustment when its screw is loosened. The carriers should be set as follows: (a) Counting *A* referred to in paragraph above as the first needle, count counter-clockwise and set the left edge of the next multiple feed yarn carrier parallel with the fifth needle or one-quarter of an inch from Needle *A*. Repeat with other carriers. (The five-needle adjustment applies only to fine gauge cylinders.) (b) The face of the multiple feed yarn carriers should be as close to the needles as possible, without actually touching.

Adjusting of the Feeder Carrier Rings (Fig. 69): In order to adjust all the multiple feed yarn carriers vertically simultaneously, loosen the four screws holding the feeder carrier ring to the sinker cam ring. Insert or remove shims (sinters will serve excellently) between the two rings to raise or lower the feeder carrier ring. The shims should be placed so that they surround the four locking screws and the height of the ring should be such that one-half to a full spoon on the open latch of the uppermost needle will be visible below the bottom edge of each multiple feed yarn carrier. The ring may also be shifted circumferentially as one unit for the knitting position adjustment.

Vertical Adjustment for Cylinder or to Achieve Extremely Loose Stitches: The cylinder may be raised or lowered by means of shims placed under the four elevating blocks on the bottom of the insert retaining ring. Loosen the four screws holding the cylinder to the cylinder gear ring and insert or remove equal number of shims under each elevating block. Sinkers of uniform thickness serve as excellent shims. For extremely loose stitches, raise the cylinder in steps of .010 of an inch and readjust stitch with micromatic stitch control. Screw all four screws down finger tight,

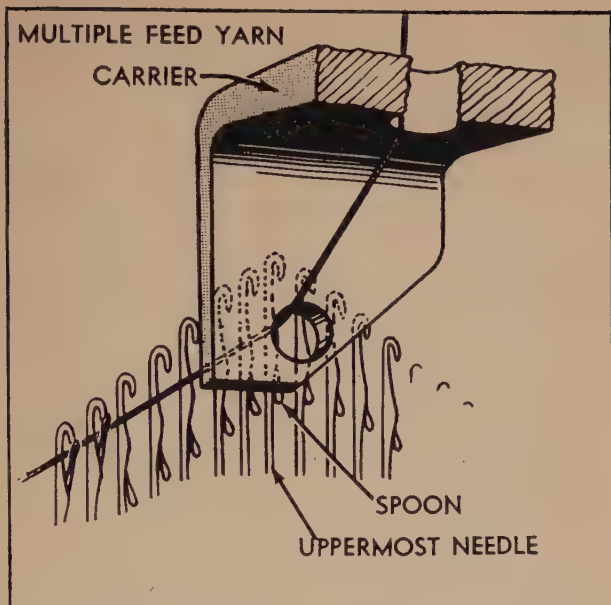


Fig. 69—Height of multiple-feed yarn carrier with relation to needle latch spoon.

then tighten all screws with screwdriver, and finally tighten all four screws permanently in place. This method of tightening will prevent tipping or uneven stressing of the cylinder.

To Adjust the Clutch: Release the clutch and raise the locking spring. Turn the adjusting ring clockwise until the operating lever requires a distinct pressure to engage the clutch. Replace the spring in the notch.

To Remove and Replace the Clutch, or to Replace Clutch Shifter Shoes (Fig. 70): Place the starting handle 4 in the vertical position. Remove the shoulder screw 1 that holds the connecting link 2 to the clutch yoke shaft lever 5. Allow the connecting link to hang free. Do not remove the taper pin holding the clutch yoke shaft lever to the clutch yoke shaft. Remove the set screw that holds the clutch 3 to the drive shaft 6. Remove the helical gear guard. Using heavy brass bar and heavy hammer, drive out

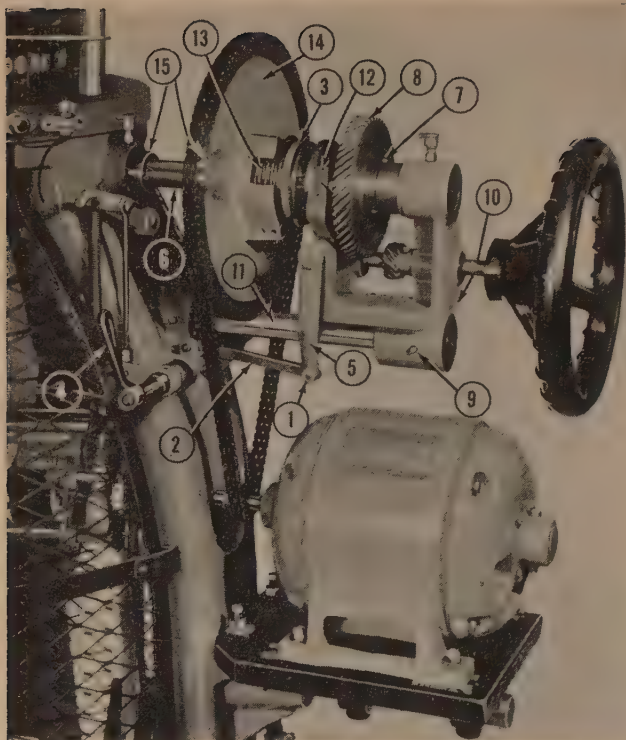


Fig. 70—Details of motor drive.

the taper pin 7 holding the 48-tooth helical gear 8 to the drive shaft. Similarly, drive out the taper pin 9 holding the drive support bracket 10 to its stationary shaft 11.

Using either a lead hammer or an ordinary hammer and wood block, carefully drive the drive support bracket off the stationary shaft. Help the operation by moving the clutch along the drive shaft. Do not allow the 48-tooth helical gear to drop on the floor. The clutch may now be slid off the drive shaft. If necessary, replace clutch shifter shoes 12 at this point. To replace the clutch, slide the plate end of the clutch onto the drive shaft. Fit the clutch shifter shoes into their groove and fit the drive support

bracket onto its stationary shaft. Push both units in slightly and place the 48-tooth helical gear on the drive shaft. Now push all units into place, making sure that the upper bearings of the drive support bracket contains the drive shaft, that the clutch shifter shoes do not bind, and that the clutch discs fit correctly in the recesses of the silent chain sprocket wheel 14. Replace all screws and taper pins.

To Take Clutch Apart (Fig. 70): Remove the clutch from the drive shaft. Release the clutch and raise the locking spring. Turn counter-clockwise approximately three turns until pressure on the discs is relieved. Then press locking plate endways toward discs. Turn it one-sixth turn in either direction and remove plate. Replace clutch.

To Replace the Pinion Gear that Drives the Cylinder Gear Ring: Remove the pinion gear guard and turn the hand wheel until the taper pin in the pinion gear is horizontal. Using a heavy brass bar and a heavy hammer, drive the taper pin out. This will prevent burring the taper pin. Now loosen but do not remove the two Allen cap head screws holding the drive leg to the outer ring. Wedge the outer ring up on the drive leg approximately one-fourth of an inch. Slide the gear off, replace and reassemble.

To Remove or Replace Large Silent Chain Sprocket Wheel: Remove the silent drive chain guard. In order to do this, it will be necessary to unscrew the connecting link. Remove the pinion gear guard of the pinion gear that drives the cylinder gear ring, then turn the hand wheel until the taper pin in the pinion gear is horizontal. Using heavy brass bar and a heavy hammer, drive the taper pin out. This will prevent burring the taper pin. Now remove the clutch. When this has been completed, loosen the set screws in the two collars on the drive shaft between the drive leg and the large silent chain sprocket wheel. Hold the sprocket wheel in place and carefully pull the drive shaft out. Replace the sprocket wheel and reassemble.

To Adjust Motor Drive Chain: Remove chain guard. In order to do this, it will be necessary to unscrew the connecting link. Loosen the two motor platform levelling screws. Then loosen the two Allen head screws in platform

and the Allen head screw in the drive leg that hold the eccentric shaft. Insert steel rod in the cross-hole of the eccentric shaft and turn clockwise to tighten chain; counter-clockwise to loosen. With fingers only, level the platform with the two levelling screws. Tighten lock nuts. Tighten all other screws. Replace chain guard and connecting link.

To Remove or Replace Motor Drive Chains: Remove the chain guard. In order to do this it will be necessary to unscrew the connecting link. Loosen the two motor platform levelling screws. Loosen the Allen head screw in the drive leg that holds the eccentric shaft. Pull the motor platform and shaft out of the drive leg one inch. (*CAUTION:* Do not exceed the one-inch limit.) Work the chain off the large silent chain sprocket wheel, lift it between the motor sprocket and the drive leg, and remove it by lifting it over the entire motor drive. Reverse the process to replace the chain, locking all screws in place.

Chapter VI. Circular Spring Needle Machinery

THE Wildman spring needle machine is built in sizes from seven to 36 inches in diameter with from six to 34 needles per inch. Fig. 71 is a view of a common style of the machine equipped with ball bearing take-up and auto-

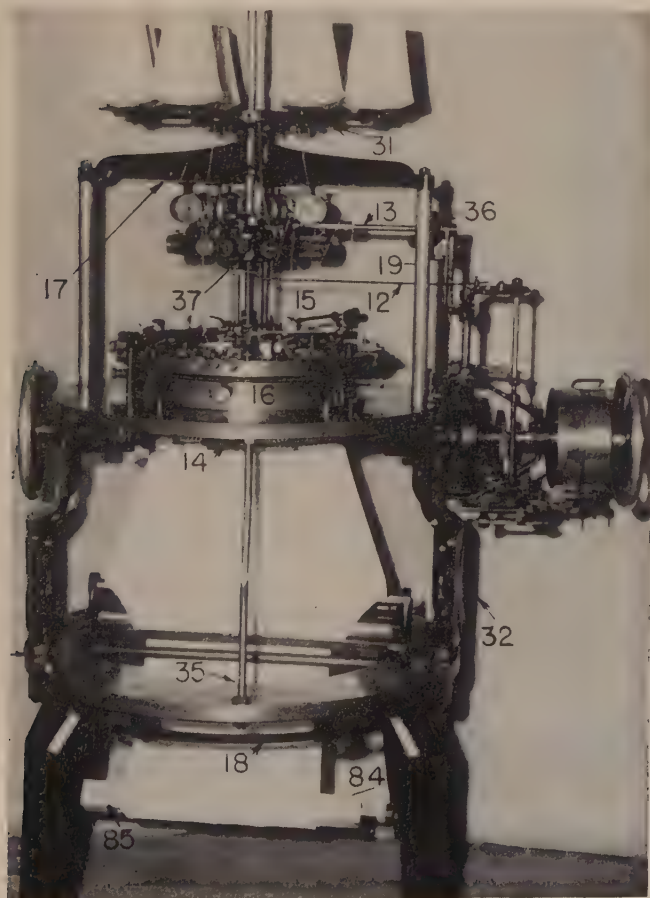


Fig. 71—Wildman spring needle body machine.

matic furnishing wheels. This construction comprises an annular base mounted upon four legs and supporting the revolving take-up carrier 35 and the housing plates 32. Upon the housing plates is mounted the head 14, which contains the revolving cylinder gear, and supports the stationary cylinder cam ring 16 and the sinker and presser cap 15. These parts are constructed in sections and may be removed individually.

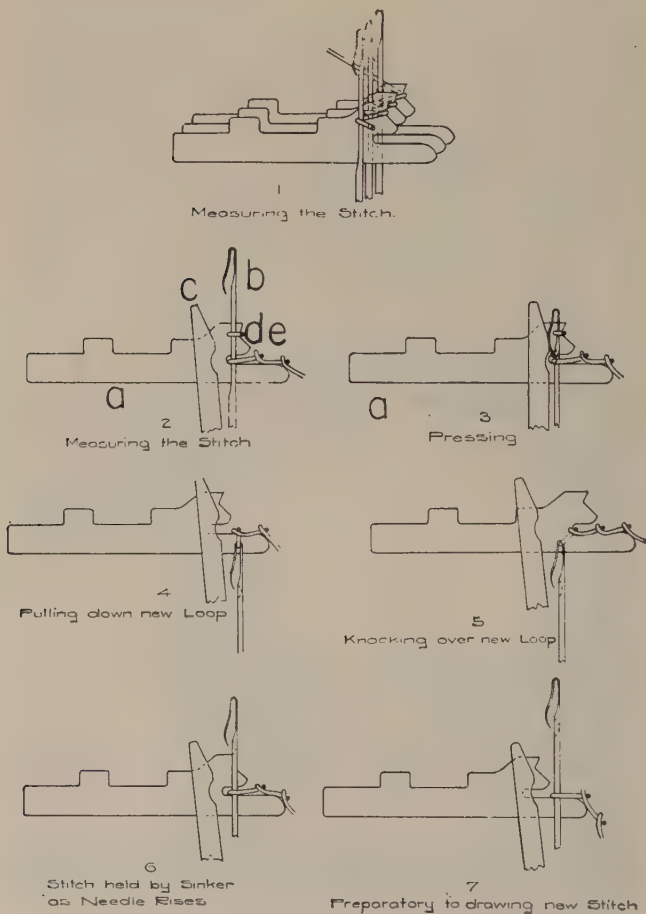


Fig. 72—Diagrams of stitch formation.

The yarn carrier 31 is supported by a bracket 17 from which is also suspended the stop motion 37 bearing the yarn furnishing wheels. The furnishing wheels are driven through shafts 13 and 19 from the main shaft, suitable velocity being given the wheels by increasing or decreasing the number of teeth in a change gear 36.

The different movements of the needle, sinker and presser in forming a stitch are illustrated in Fig. 72. At 1 the sinkers are in the process of measuring stitches. The yarn is fed between the stem of the needle and the nose of the sinker. The sinker on passing between two needles measures a stitch the length of which is determined by the setting of its actuating cam. At 2 the sinker *a* has measured the stitch *d* preparatory to passing it through the old loop *e*. At 3 the needle has been lowered until the beard comes below the new loop. The presser *c* closes the spring beard allowing it to pass through the old loop with the new as at 4. At 5 the sinker has advanced, engaging the loop this time in its throat carrying it over out of the path through which the needle must rise. The needle has risen at 6 while the loop has been held down by the sinker. The sinker is withdrawn at 7. The needle is rising to receive a new stitch and repeat the operation.

The cylinder cams consist of the usual combination of a raising or clearing cam, guard cam, and a stitch cam suitably shaped for imparting proper movements to the needle at the correct time. Fig. 73 is a view of a section of the cam ring exposing the needle draw down cam *A* and the guard cam *B*. Cam *B* is attached to the stem of the draw-down cam and any adjustment of the stitch at this point raises and lowers cam *B* also. This feature insures that the tension on the new loop is relieved in a positive manner directly after its formation. Fig. 73 also shows the micrometer adjustment *D* applied to the draw down cam. In starting a new machine these are set to draw the same length stitch by means of calipers. The graduated verniers of all adjustments are then set to read the same. Any later change which may be required is quickly made by turning each adjustment an equal number of divisions by the pointer.

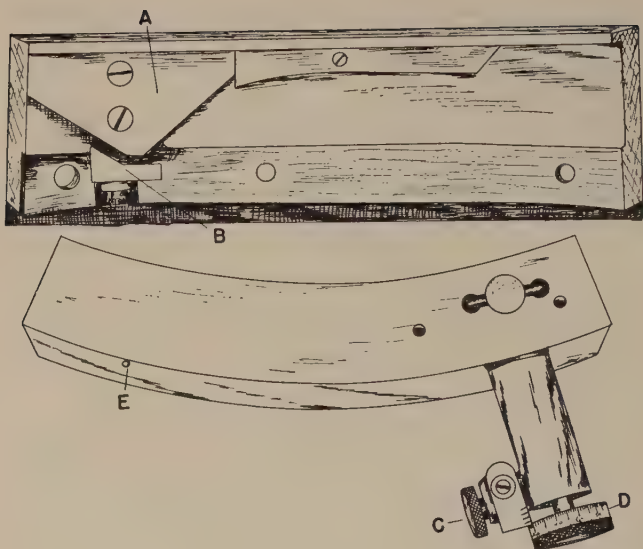


Fig. 73—Sinker cams and micrometer adjustments.

The cams which control the sinkers and pressers in measuring the stitch, closing the beard, and knocking over the stitch are contained in the sinker cap, a section of which is shown at Fig. 74. *F* is the measuring cam which forces in the sinker as at 1 and 2, Fig. 72. *G*, Fig. 74, is the presser cam which operates the presser as shown at 3, Fig. 72. *H* is the knock-over cam which throws the sinker to position 5, Fig. 72. The lower half of Fig. 74 shows the top view of the section with micrometer adjustments *A*, *B* and *C* for measuring, pressing and knocking-over, respectively.

The knock-over cam *H*, Fig. 74 is moved in or out by turning the screw *C* in the same manner as the stitch cams are adjusted and when any change is made in the stitch a corresponding change must be made in the knock-over cam setting.

In the case there is any question as to the relative positions of the knock-over cams at the various feeds, they should all be set alike by the following method: Set one cam at a time

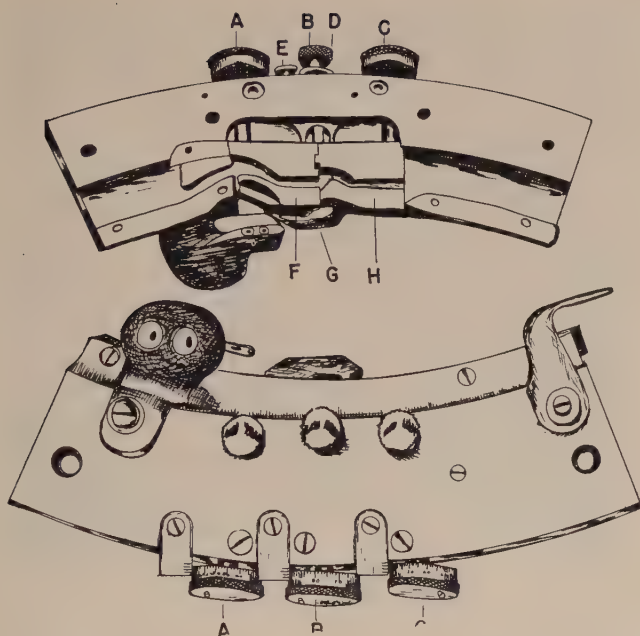


Fig. 74—Needle cams and micrometer adjustments.

slowly inward while the machine is in operation until holes appear in the fabric. Then set the cam back about 50 graduations. This will put it in a safe working position. After adjusting all knock-over cams in this manner the graduated collars should be set to the same reading at all feeds.

To adjust a presser cam, slowly run out the presser cam adjusting screw while the machine is in operation until tuck stitches appear in the fabric. Then turn the adjustment slowly to the right until the tuck stitches disappear. Lock the adjustment in place. Adjust all cams in this manner.

Automatic measuring or furnishing wheels are provided whereby equal amounts of yarn are supplied each feed to aid in securing an even stitch and a uniform fabric. Where furnishing wheels are not used, the needles draw the yarn from the cone. Furnishing wheels relieve them of this strain.

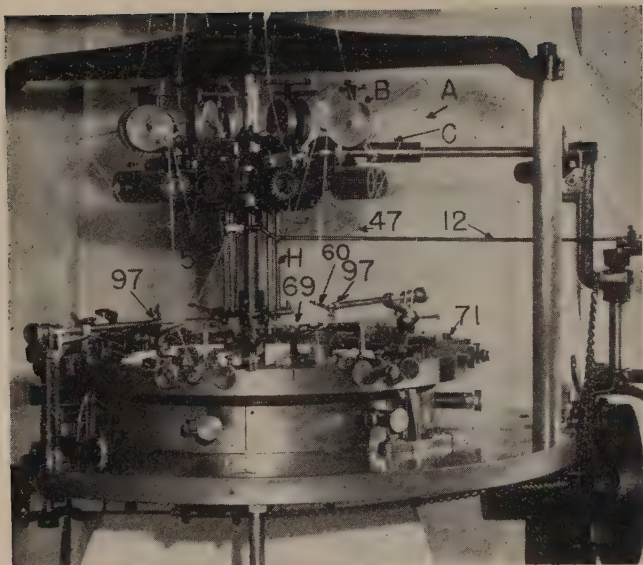


Fig. 75—The machine head, showing measuring wheels.

Fig. 75 is a view of the machine head and the measuring wheels. The measuring wheels consist of a pair of intermeshing gears slightly bevelled. The amount of yarn delivered may be regulated to suit the stitch being used by changing gears. Slight alterations in the amount of yarn delivered are taken care of by the guiding disc *B*. When the tension on the thread increases, the guide *A* is drawn down. This partly revolves the disc *B* and shifts the thread guide *C* toward the larger end of the furnishing wheels where the surface speed is greater. The rate of delivery is increased. When the thread becomes slack the opposite action takes place.

When a thread breaks between the furnishing wheels and the feed, the fingers such as 47 drop and trip a trigger mechanism in the stop motion head allowing an arm 54 to be partly revolved. The motion is transmitted through rod 12 to the trip device which arrests the machine. Simultaneously rod *H* is partly revolved and in doing so operates the trigger mechanism 71 through connecting

rod 69. This releases the presser cam at this feed and allows the needles to tuck while the machine is stopping to prevent their knitting out of their stitches.

Hole detectors shown at 60 and 97, Fig. 75, automatically stop the machine when a hole is formed in the fabric. The needle bears lightly upon the cloth under force from a spring acting on collar 97. The point of the needle drops into any hole which may be formed or becomes engaged by other imperfections which may be produced and automatically stops the machine. In case it is necessary to operate the machine while holes are in the area of the detector needles as in the case of adjusting the machine or starting after a press-off, the detectors may be thrown out of action by partly revolving the collar 97.

As the fabric descends from the needles it passes under one roll and over another and downward to the winding arbor 85, Fig. 71. The roll is mounted so that it may swing up and down through an arc of about 30° , and by means of a clever arrangement of mechanical devices operates the take-up.

Starting the Machine After a Press-Off

In starting up after a press-off the fabric does not have to be hooked onto the needles, as must be done with a rib machine. Simply thread the yarns through the yarn carriers and after turning the machine a couple of revolutions by hand to make sure the yarns are all feeding into the upper throat of the sinkers, apply the power.

Sometimes in starting up, when a loose stitch is being knitted, or when drop stitch fabric is being made, the fabric will ride up over the nose of the sinkers. If this happens, push the fabric down in front of each yarn carrier and turn the machine by hand until the fabric stays in the lower throat of the sinkers. Never run the machine when the fabric is climbing up on the sinkers as it soon loads up on the needles and causes a smash.

TROUBLE	CAUSE	REMEDY
Fabric loads up on individual needles.	Presser missing or bent. Beard of needle bent or broken.	Put in new presser. Straighten the beard or put in new needle.
Fabric loads up on all needles	Presser cams not held in position by triggers.	Set the presser cams.
Fabric runs off the needles.	Stitch too tight for yarn being used. Yarn broken. Yarn running into the lower throat of the sinkers at one of the feeds.	Loosen stitch. Mend yarn. Raise yarn into upper throat of sinker. If it continues to run in lower throat, raise yarn carrier.
Fabric very loose above the take-up rolls.	Catch is pulled out or clutch does not operate.	Turn the catch until it drops into position to drive the winding roll. Adjust clutch. (See adjustments under take-up.)
Fabric very tight above the take-up rolls	The take-up clutch does not release.	Adjust clutch so that it releases before roll reaches the top of its swing. (See adjustment of take-up.)
The yarn is continually breaking between the furnishing wheels and the needles.	The wheels are feeding the yarn too slowly.	Set the gears closer together by turning back on the adjusting nuts. If this does not give the desired result, change the gears to a set which will drive the furnisher wheels faster.
Furnishing wheels chatter.	Wheels are set too close together.	Separate the wheels slightly by turning down on the adjusting nuts.
Fuzz on the face of the fabric.	Rough needles or sinkers. Needle pull down cams set too far down, or the knock-over cams in too far.	Replace defective needles or sinkers. Adjust the cams.
Tuck stitches appearing in vertical lines in the fabric.	Bent needles or pressers or needles with defective beards.	Replace the needles or pressers causing the trouble.
Tuck stitches appearing irregularly all over the fabric.	Presser cam or cams not set in far enough. Needle pull down cams too far up or knock-over cams not in far enough.	Adjust cams. Adjust cams.
Holes appearing in vertical lines in the fabric.	Broken, bent or rough needles or sinkers.	Replace needles or sinkers.

TROUBLE	CAUSE	REMEDY
Holes appearing irregularly over the fabric.	Pull-down cams set too low or knock-over cams too far in.	Adjust the cams.
	Cap set too far to the left.	Set cap slowly to the right.
	Poor yarn, full of knots and bunches.	Use better yarn.
	Too much tension on the yarn, due to drag or poor winding.	Make sure all parts over which the yarn runs are smooth. Adjust the furnishing wheels or stop motion so as to decrease the tension. Wind the yarn carefully.
Horizontal streaks in the fabric.	Stitches not balanced. Yarns not all of the same weight.	Equalize the stitch. Select the yarns more carefully.
Vertical streaks in the fabric.	Bent needles or sinkers, or needles and sinkers not of the proper length.	Replace the defective needles or sinkers.

Chapter VII. Spring Needle Fabric Production With The Loop Wheel Machine

CIRCULAR spring needle machines of the loop wheel type have been used for many years in the production of fabric for underwear and certain classes of outerwear. The chief characteristics of the loop wheel machine are the manner in which the needles are held in the cylinder and the operation of forming the stitch. The needles are rigidly fixed at uniform height and are not capable of being raised or lowered in relation to the fabric. The cylinder rotates and the fabric is raised and lowered in relation to the needle to accomplish the same result as raising and lowering the needles which occurs in most types of knitting machines.

Loop wheel machines are built in both leaded needle and trick needle types. In the leaded needle type the needles are placed in a mould into which is poured molten lead or an alloy of lead and other slightly harder metals. Two or more needles are cast together and these are arranged side by side around the cylinder and are held in place by clamps which cover them and retain them rigidly in place. In the trick needle type of machine the cylinder is cut with slots for receiving the needles and in this machine the needle may be removed individually, while in the leaded needle type of machine all the needles in the lead must be removed and replaced in case one is broken.

The loop wheel machine is an extremely flexible machine and this factor, together with the quality of the work it is capable of doing and the fact that it is a good producer, accounts for its popularity in knit fabric production. In the leaded needle type the gauge of the machine may readily be changed by removing all the needles and placing in the same cylinder the gauge needles desired. In this manner it is possible to knit a heavy sweater fabric with needles as coarse as five-gauge or underwear fabrics in gauges run-

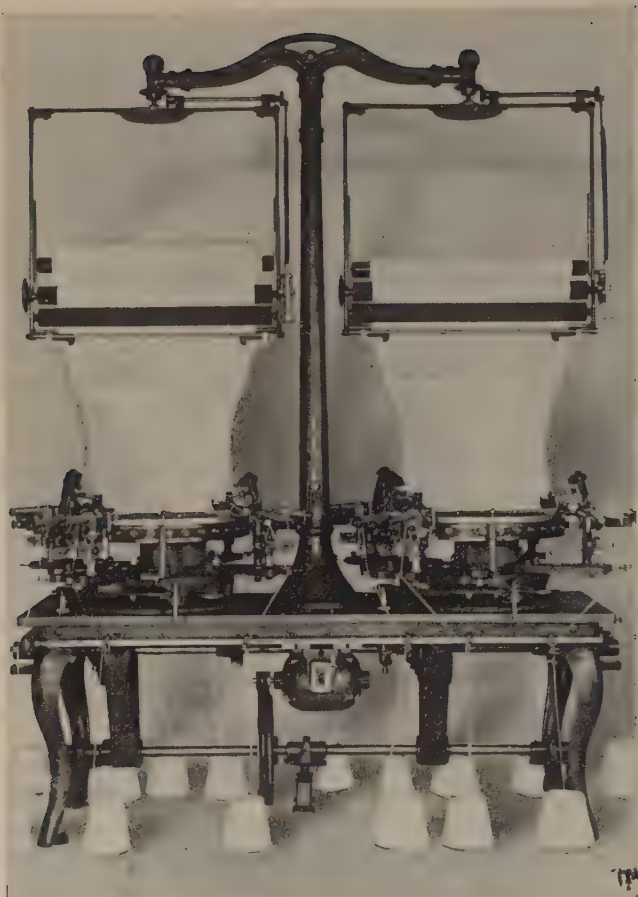


Fig. 76—The table type, double-head Tompkins spring needle machine.

ning up to 50. The size of the cylinder is also important in knitting body sizes and on this score the loop wheel machine is highly flexible. The same basic machine may be employed to knit with cylinder diameters ranging from eight inches for the smallest up to 30 inches or more for certain types of machines.

The conventional loop wheel machine is built on a table with two heads to each table. The heads are driven from

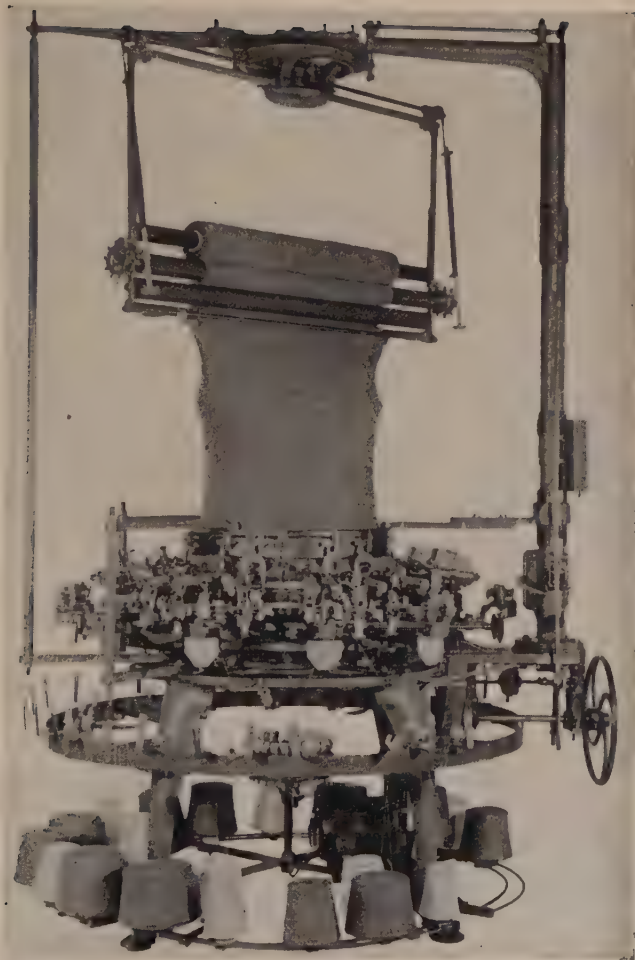


Fig. 76a—The Tompkins single-head machine.

a single shaft mounted underneath the table but these are operated independently of each other. The number of feeds is optional and may be varied from one up to as many as ten where the diameter of the cylinder permits. A feed consists of a group of mechanisms capable of forming stitches upon the needles and casting them off as a part of

the fabric. The number of these devices employed varies with the class of work, but in general the following are used at each feeding unit:

(1) Sinker bur for placing the yarn on the needles in sufficient length to form the stitch and delivering it under the beards.

(2) Thread guide to place the yarn on the sinker bur.

(3) Lander bur to raise the fabric to bring the old loop in proper position for passing over the beard while it is closed.

(4) Presser to close the needle beards.

(5) Cast-off bur for knocking over the stitch and insure its delivery from the head of the needle into the fabric.

(6) Clearing bur. This bur is optional and is employed as a safety device to protect the beards from damage from a slub, seed, or gout. The clearing bur precedes all the others and in the case of a four-feed machine clearing burs are recommended for feeds number two and four.

(7) Fabric wheel. This wheel is a metal disc mounted inside the needle circle even with the sinker bur and is free to rotate with the fabric as the cylinder is revolved. Its purpose is to depress the fabric on the needles until the old loop is at the bottom of the needle touching the rim of the needle cylinder or leads.

The Tompkins loop wheel spring needle machine is constructed with two needle cylinders mounted on a table from which the knitted fabric is drawn upward and wound on rolls provided with suitable take-up and driving equipment that functions in harmony with the knitting heads.

The cylinder is shown in detail in Fig. 77. The holes in the rim of the cylinder are for the screws used to tighten the clamps that hold in place the leads containing the needles. The cylinder is shown in two views—top and side; 2 is the spur gear which is fastened to the hub of the cylinder and drives it; 3 is an iron ring, the bottom spreader, secured to the vertical shaft, and serves to keep the web in the cylindrical form in which it left the needles; 4 is an elliptical ring, the top spreader, also secured to

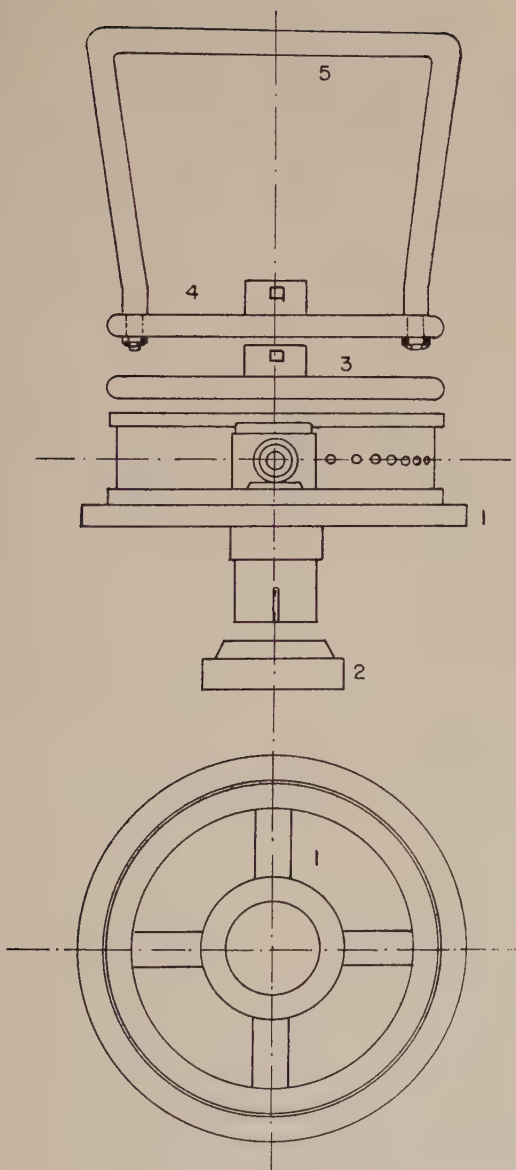


Fig. 77—Diagram showing principal parts of the loop wheel machine.

the vertical shaft, which serves to guide the web to the winding or take-up rolls and present it in better shape to be rolled up on the rolls. Bottom spreader 3, being the same shape as the cylinder equalizes the tension of the cloth on the needles at all points around the cylinder, while the top spreader 4, shapes and guides the web to the take-up rollers so that it may be rolled up. To top spreader 4 is fastened the spreader bow 5 which is secured to the take-up and drives it.

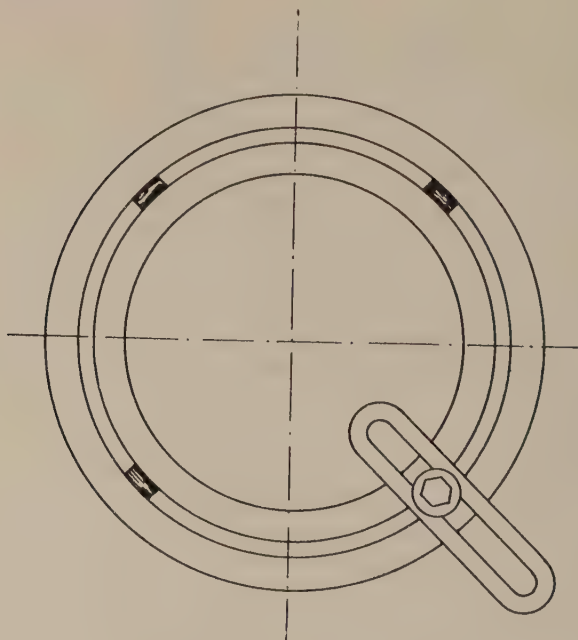


Fig. 78—Diagram of the outer ring and link.

Fig. 78 illustrates an outside circle and link. The link on this circle is adjustable to almost any desired position. The circle is mounted on the projections rising from the bed-plate, seen in Fig. 76, which brings it below the cylinder. The links bolted to this circle support the stands on which the outside burs and wheels run.

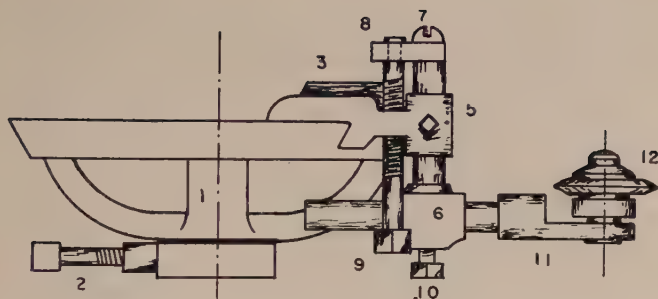


Fig. 79—Diagram of inside ring, showing lander bur and stand.

Fig. 79 shows the inside plate or ring, supported by four ribbed arms and secured to the cylinder stationary stud by set screw 2. On the ring are fixed the bur holders 3, which support the inside bur arms 11. The ring is dovetailed and each bur holder is clamped to it by a set screw on the inner ends. When the screw is loosened the bur holder may be moved circumferentially to any position without otherwise altering the position of the bur. The bur arm 11 may be rotated by loosening set screw 5 and allowing the holder 6 to be moved as desired. It can also be adjusted in and out with the use of set screw 10, and is capable of adjustment up and down by means of the right and left screw 9. On the end of bur arm 11 is the bur 12. When the web of cloth is on the machine the inside plate and inside burs are hidden from sight.

The sinker stand is a mechanical arrangement on the outside ring for supporting the sinker bur and the cloth wheel. The sinker bur feeds the yarn up under the beards of the needles. The cloth wheel is so arranged that it projects over and inside of the needles opposite the sinker bur and by means of the wide flange holds down the cloth leaving the tops of the needles clear to permit the sinker bur laying a new set of stitches under the beards of the needles.

The sinker stand is bolted to the links. The tube is bolted to the stand. This tube contains a shaft on which is mounted a coil spring. When the parts are assembled the spring

is confined between the shoulder on the shaft and the collar partially inserted in the tube and secured to it by a set screw provided with a nut and a lock nut. This feature gives a yielding pressure to the shaft which supports the bracket with a stud which revolves the sinker bur. The interior shaft has a rotary adjustment and is adjusted in and out by the nuts on the outer end of the shaft. When a bunch gets in under the bur, the shaft allows the bur to move back against the spring. After the bunch has passed, the spring returns the bur to its position, leaving the needles uninjured. At the top of the stand on the offset directly over the sinker bur, is supported the cloth wheel stud secured to the stand. The cloth wheel is numbered 2 in Fig. 83.

The presser stand, Fig. 80, supports the presser on the outside of the needles, holding the beards of the needles down over the yarn while the lander bur raises the cloth and lands the stitches on the beards. The presser stand 1

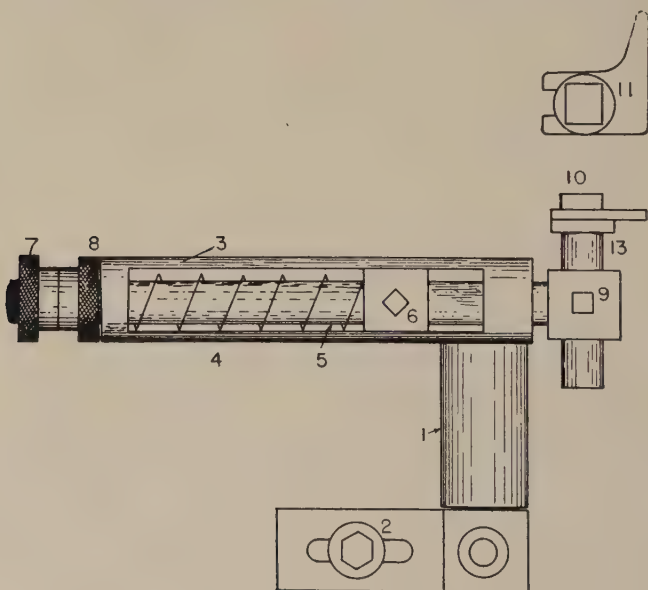


Fig. 80—Diagram of presser stand and plain presser.

is bolted in position on the link. The tube 3 is held in position on the stand with a screw. The presser shaft 5 is supported inside the tube 3, and there is a spring confined between the shoulder 6 on the shaft and the end of tube, and is adjusted and set by means of lock nuts on the outer end. The inner end of the shaft holds the presser stud 13 fastened with a set screw 9. This stud is adjusted up and down and on it the presser is mounted.

The presser shown is a flat presser which slides in contact with the needles. Flat or stationary pressers are used instead of round pressers. These close the beards of the needles by a sliding motion between needle beards and presser.

The Tompkins machine has a shaft at the bottom of the frame extending the length and projecting so that the receiving pulley may be driven from either end. On the shaft are two pulleys each driving a separate counter shaft—one for each cylinder—directly under the table. Each of these counters has a clutch pulley and the cylinder is started and stopped by means of a lever which is mounted on top of the table within easy reach of the operator. On each counter is a bevel pinion that meshes with a bevel gear driving the double pinion shown under the cylinder. The upper spur gear of the double pinion drives the cylinder and the lower half drives the center shaft. The gear on the lower end of the vertical shaft is hidden by the bedplate, but is shown in detail in Fig. 81. This vertical shaft drives the take-up, revolves in the same direction as the cylinder, and makes the same number of revolutions per minute. The connections from the shipper to the cylinder and vertical shaft are shown in detail, and function as follows: The shipper opens and closes the clutch to transmit power to the counter shaft, to which is fastened a bevel pinion meshing with a bevel gear which drives a shaft running in the upright sleeve at the upper end of which is fastened the double pinion 8 and 9. Pinion 2 drives a gear 3 which is fastened to the vertical shaft that drives the take-up. The other pinion 1 drives gear 4 which transmits power to the needle cylinder 5.

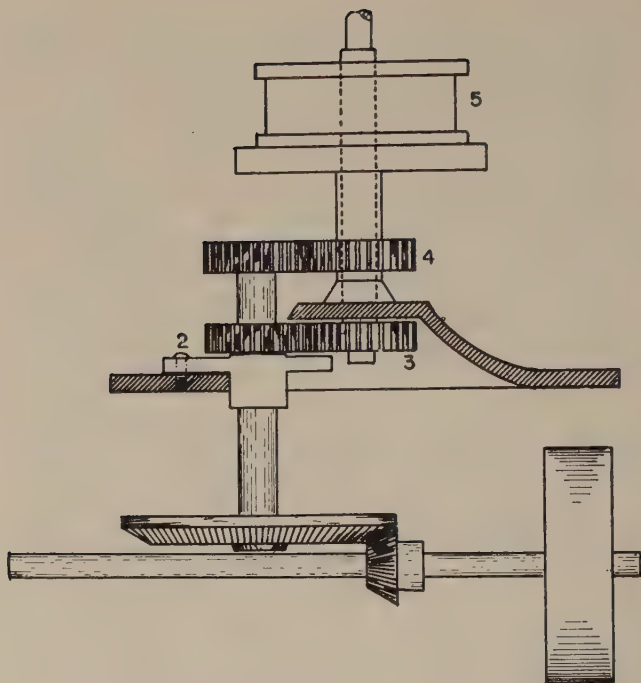


Fig. 81—Diagram of driving system of the loop wheel machine.

The stop motion, Fig. 82, is an arrangement for automatically stopping the cylinder. When holes in the cloth or bunches of yarn in the needles appear, the stop motion opens the clutch and quickly stops the cylinder. The stop motion is supported on a link secured to the outside circle in the same manner as the stands. When the finger 15 finds a hole in the web, or the feeler 19 encounters a bunch of yarn or fly in the needles, spindle 6 is rotated enough to disengage the lever 22 which is supported at the end of the adjustable shaft 21 and its connections disconnects the clutch to stop the cylinder.

The take-up removes the cloth from the needles as fast as it is knitted, and maintains the proper tension on the needles. To take it up too slowly would cause an accumulation of yarn in the needles. To take up too fast would cause

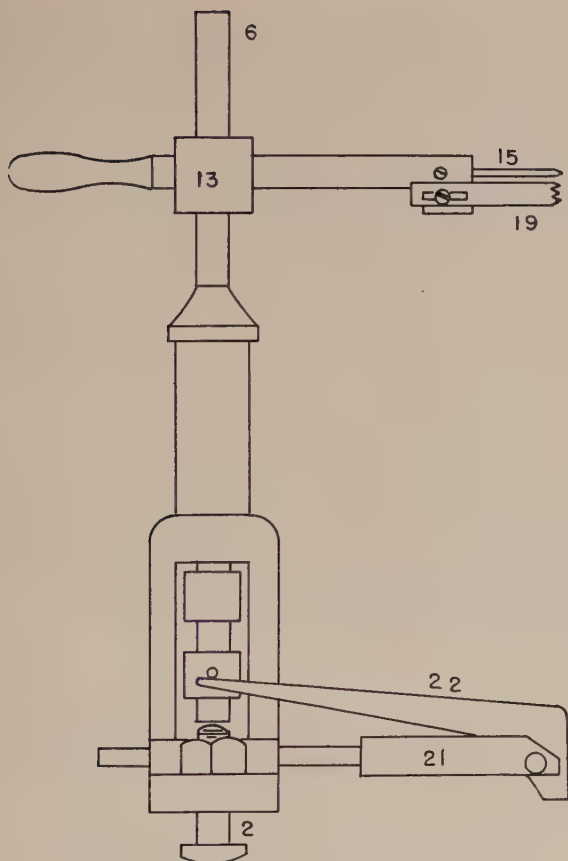


Fig. 82—Diagram of the stop motion.

a severe strain on the needles. The effects of either would be broken needles, a smash, uneven cloth tucks and possibly a pull off. The take-up consists of three rollers contained in a frame with connecting mechanism to turn them in the required manner. It is suspended to the cross-tree extending from the top of the central column of the machine and is driven by the spreader bow inside of the web and between the two rods at the bottom of the frame. The spreader bow is supported and rotated by the vertical shaft. The

weight of the take-up is supported by a hardened rounded steel collar seated in a hardened steel cup, sufficiently free to allow the take-up to move readily without leaving it too free to continue rotating after the stop motion has released the shipper. The bevel pinion on top of the frame receives its motion from the standing gear on the cross-tree and by means of the crank and spring connecting rod, and reciprocates the dog engaging the ratchet gear on the end of the upper emery covered roll. When the tension on the cloth is properly adjusted the unnecessary take-up motion is absorbed by a spring. The adjustment of this spring connecting rod device determines the degree of tension on the cloth and is a most important factor in producing good cloth with a minimum of broken needles.

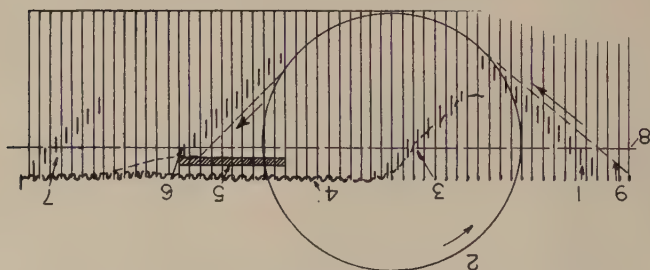


Fig. 83—Diagram of stitch formation: (1) clearing bur; (2) fabric draw down wheel; (3) sinker bur; (4) yarn placed under beards, new of needle beards; (9) fabric line, old course.

When the tension on the cloth between the needles and the draft rollers will permit, the pawl engages with the ratchet wheel to cause the draft roll to move forward as far as is necessary to equalize the strain on the cloth. This tension is adjusted by means of a spring. When the spring is at its full adjusted length the tension of the cloth is greater than the resisting force of the spring, but as more courses are knitted the tension of the cloth relaxes and the ratchet wheel yields to the pressure of the spring connecting rod turning the roll, taking up the slack cloth and maintaining the proper tension on the cloth between the needles and the rolls. As the web is taken up it winds on the wooden roll, and when the roll is sufficiently large the

cloth is cut and the roll removed by lifting out of the parallel ways on the inside of the frame. When it is desired to unwind the cloth, both dogs may be thrown out of gear by pushing up the handle attached to the gear cover.

The large cylinder shown in Fig. 81 is the needle cylinder. The direction in which this cylinder turns is counter-clockwise. Beside the cylinder and above it is the inside ring, Fig. 79, on which are the bur holders. The center or vertical shaft is seen projecting up through the center.

Fabric Formation

A feed is a group of burs and wheels necessary to the formation of a complete stitch. Beginning at Fig. 84, which shows the combination required for plain jersey, and extending through Fig. 93, various combinations are shown for making a variety of fabrics. These combinations constitute a feed in each case. The lander and cast-off burs are not shown in these illustrations. It should be remembered that a lander bur will accompany each presser and a cast-off bur will follow each lander. In some cases a combination lander and cast-off bur is used. The combination bur occupies less space in the cylinder circumference than the lander and cast-off together and permits the use of more feeds in a machine of a given size. Plush cloth knit in this manner is used for cloaks, overcoats, horse blankets, buffalo robes, and underwear.

The plain feed requires three burs, a cloth wheel, and a presser. The cloth wheel is the largest of the group. Just under the hub of the cloth wheel is the sinker bur. Next comes the presser wheel on the outside of the needles; the lander bur on the inside of the needles and the cast-off bur which raises the stitch off the needles. Knitting machines are usually furnished with four feeds to a cylinder, but more may be employed for larger sized cylinders. The production of a machine is proportional to the number of feeds.

Single plush, Fig. 88, is plain knitting with a yarn looped in each course of plain stitches. As it is usually made it is looped in one stitch, then skips two stitches on

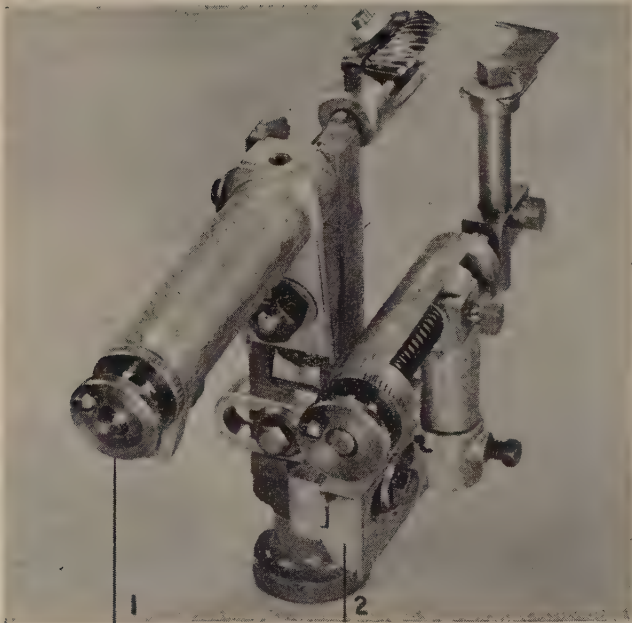


Fig. 84—Arrangement for plain jersey: (1) sinker bur; (2) plain presser.

the back, and is then looped in another stitch and so on, thus making this yarn appear on the back of the cloth almost entirely. The single plush feed is essentially the same as the plain feed, except that a backing bur and a clearing bur are employed in addition to the burs used in the plain feed. The backing bur cannot carry the yarn down far enough on the needles, so the clearing bur is employed to assist it, just as the cast-off bur assists the lander.

The feed, shown in Fig. 88 is a single plush feed with single backing. Taking the burs and wheels in order, they are as follows: plush feeder bur 1, clearing bur 2, sinker bur 3, and plain presser 4.

As the cloth wheel has to cover three burs instead of one—as in the plain feed—it should be larger than that required for a plain feed. On the other hand the large

cloth wheel will serve for a plain feed. The backing bur and the clearing bur are held on the stud by a nut because the work tends to lift them off the stud. The backing yarn is fed into the bur by the guide. Sometimes the clearing bur is supported by a bracket secured to the backing stand. A flat presser is normally used but a jack presser or the small round presser may be employed.

A double plush feed, Fig. 90, may be made from a single plush feed by separating the single plush feed in the middle and inserting a sinker bur, presser and lander. It is then necessary to use another cloth wheel or use a wide shoe presser on the original sinker stand. The added sinker puts in what is called the binding thread, and the presser and lander place it on the beards of the needles.

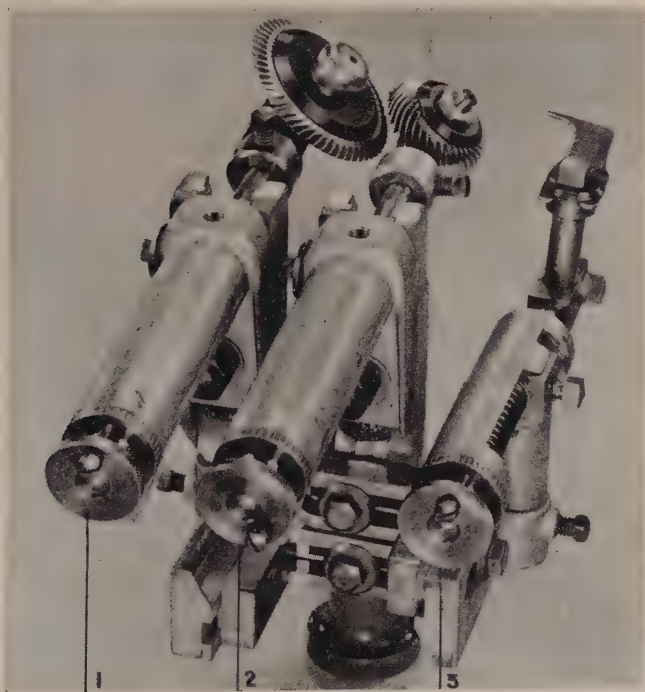


Fig. 85—Arrangement for plain jersey: (1) clearing bur; (2) sinker bur; (3) plain presser.

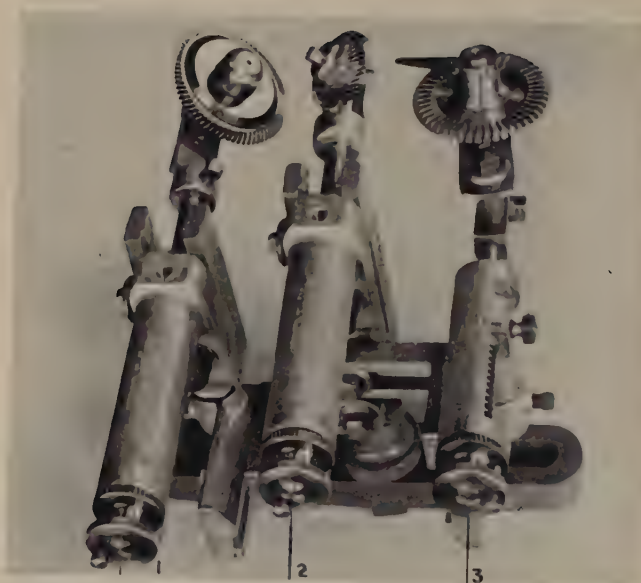


Fig. 86—Arrangement for plain jersey: (1) clearing bur; (2) sinker bur; (3) jack presser.

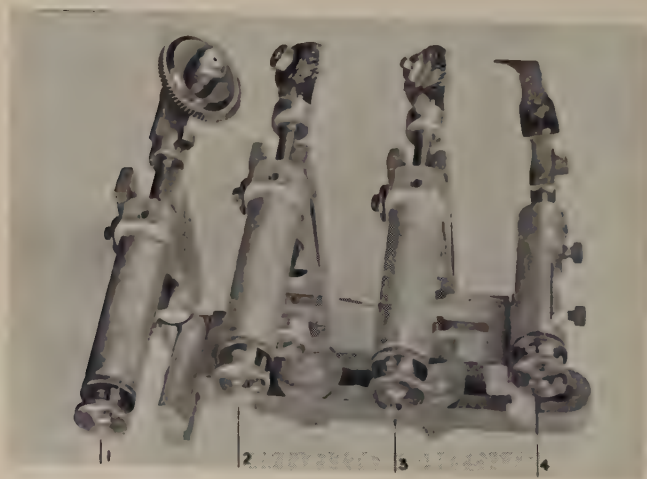


Fig. 87—Arrangement for terry cloth: (1) clearing bur; (2) terry bur; (3) sinker bur; (4) plain presser.

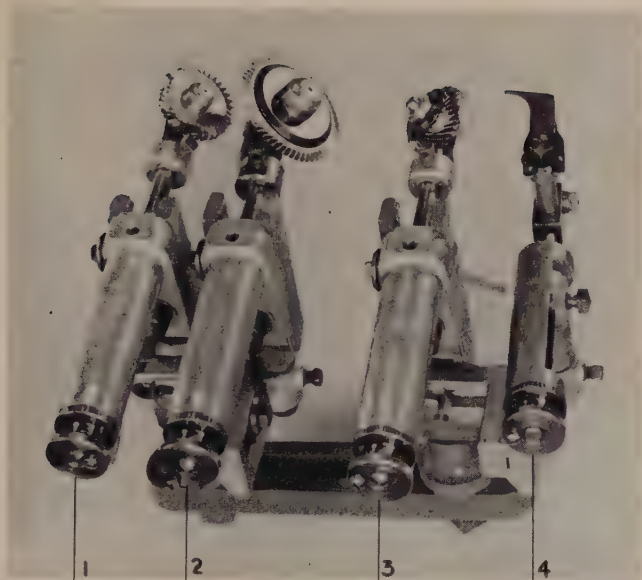


Fig. 88—Arrangement for single plush with single backing: (1) plush feeder bur; (2) clearing bur; (3) sinker bur; (4) plain presser.

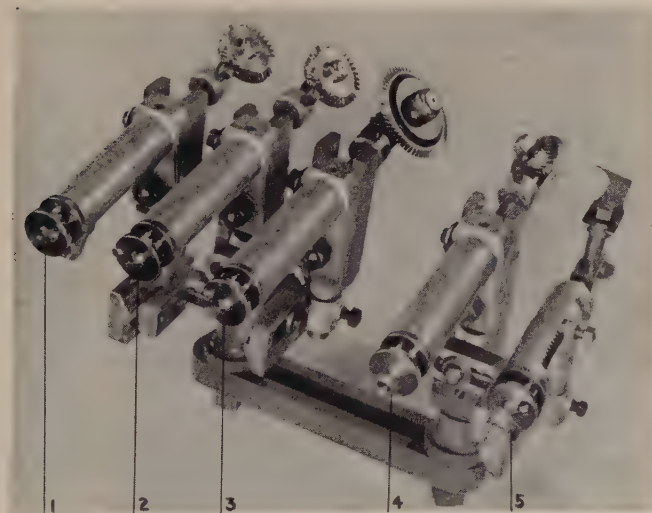


Fig. 89—Arrangement for single plush with double backing: (1) plush feeder; (2) plush feeder; (3) sinker bur; (4) sinker bur; (5) presser.

The production of a machine is proportional to the number of feeds but it is not good practice to crowd in as many feeds as the circumference of the cylinder will permit. In such cases the only space at which needles may be removed

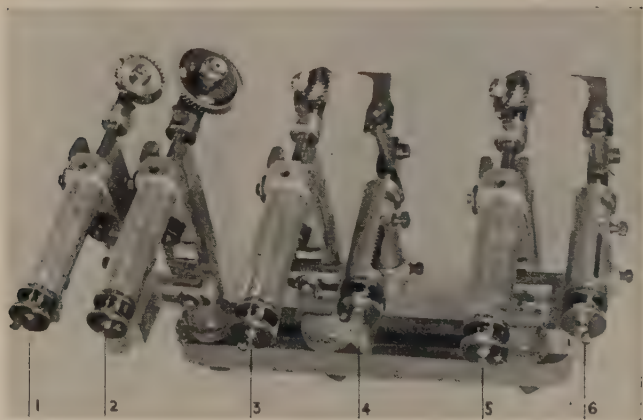


Fig. 90—Arrangement for double plush with single backing: (1) plush feeder; (2) clearing bur; (3) sinker bur; (4) presser; (5) sinker bur; (6) presser.

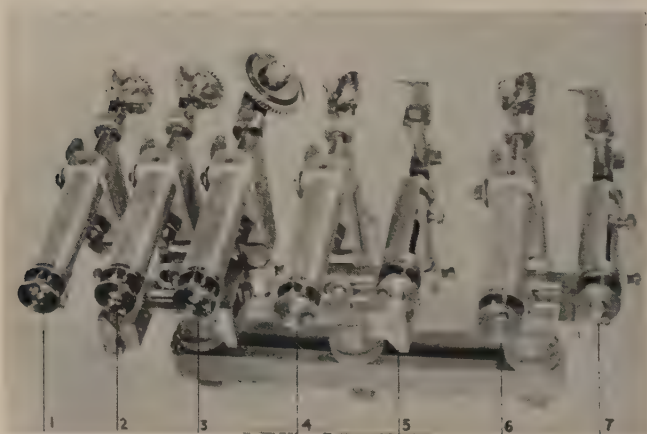


Fig. 91—Arrangement for double plush with double backing: (1) plush feeder; (2) plush feeder; (3) clearing bur; (4) sinker bur; (5) presser; (6) sinker bur; (7) presser.

and replaced is at the stop motion, and a smash located at any other point must be moved around to that point. This complicates the correction of the trouble. Another objection against crowding in too many feeds to a cylinder is

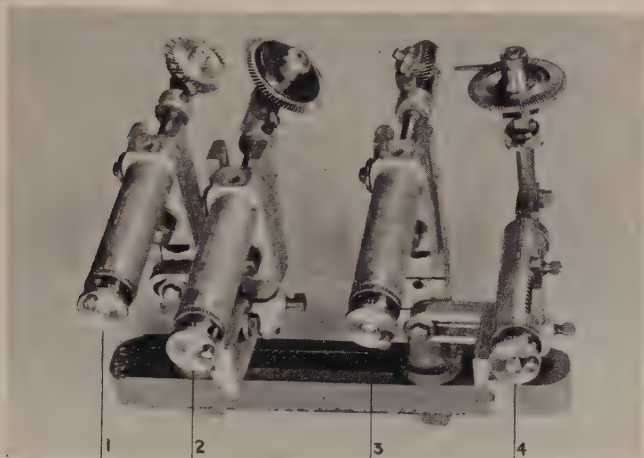


Fig. 92—Single plush with single backing and jack presser: (1) plush feeder; (2) clearing bur; (3) sinker bur; (4) jack presser.

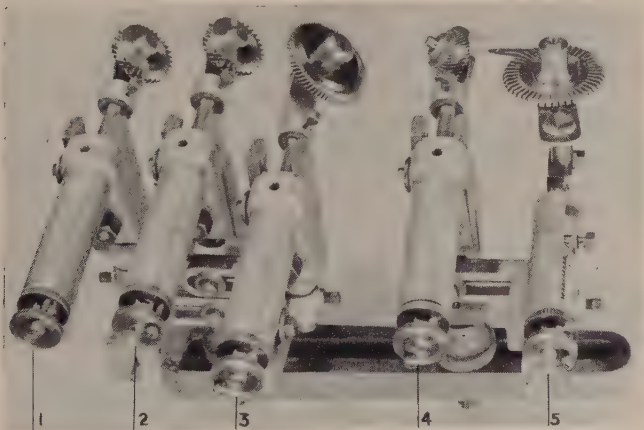


Fig. 93—Single plush with double backing and jack presser: (1) plush feeder; (2) plush feeder; (3) clearing bur; (4) sinker bur; (5) jack presser.

that more breaks, bunches, smashes, holes, etc., appear in proportion to the increased number of feeds, thus causing an increased number of stops. Every stop reduces production. An increase in stoppage may easily offset the increased production of one of the feeds. Therefore it is a matter of judgment as to how many feeds may be profitably employed—stops, quality of yarn and fabric considered.

Burs are usually made with bronze bodies, though other metals and compositions are employed by different machine builders. The blades are of steel specially hardened and tempered in most instances, but often treated as the style of the bur may require. The bushings are made of case-hardened steel and are removable. The blades not only differ for the various functions they have to perform but differ for the same employment according to the ideas of the designer, knitter or maker.

Inside burs have a self oiler, or the bur arms are provided with oilers that do not require replenishing for two or three days. This is very essential, for when the fabric is stretched from the needles to the take-up, the inside burs are accessible only after cutting the web. They are difficult

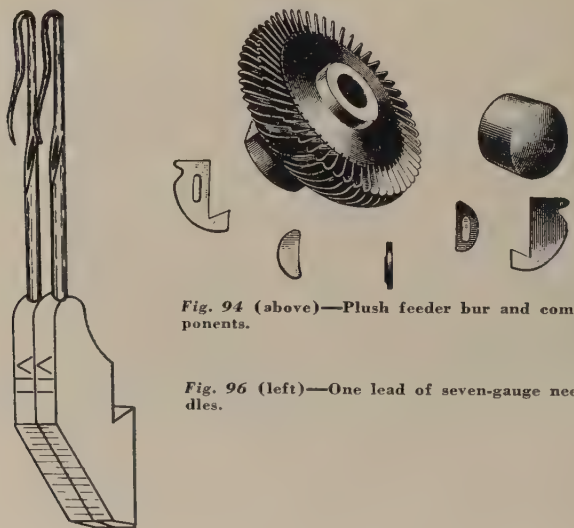


Fig. 94 (above)—Plush feeder bur and components.

Fig. 96 (left)—One lead of seven-gauge needles.

to get at in any machine. In some machines the cylinder is set high enough above the table to allow the knitter to reach up under it to clean and adjust without cutting the cloth. In some machines the cylinder is close to the table.

The feed burs must correspond with the gauge of the needles. The blades can be removed in case of wear and new ones inserted. The burs push the yarn into and between the needles and in other ways manipulate it until it is cleared off the needles into cloth. The blades strike the yarn quick sharp blows and consequently are a considerable factor in determining the speed of the machine.

The backing bur, Fig. 94, is for lacing among the needles

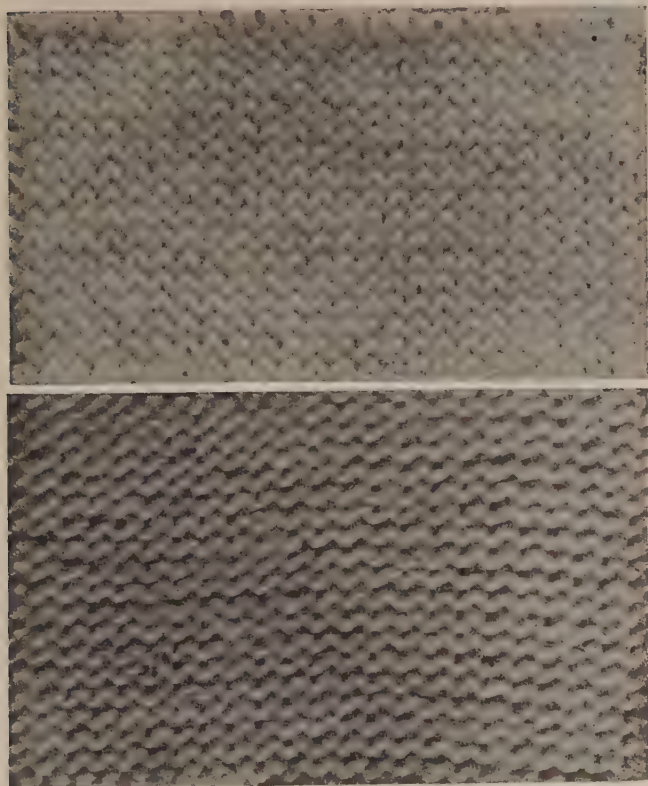


Fig. 95—Eight-gauge spring needle fabric; face at top, back is below.

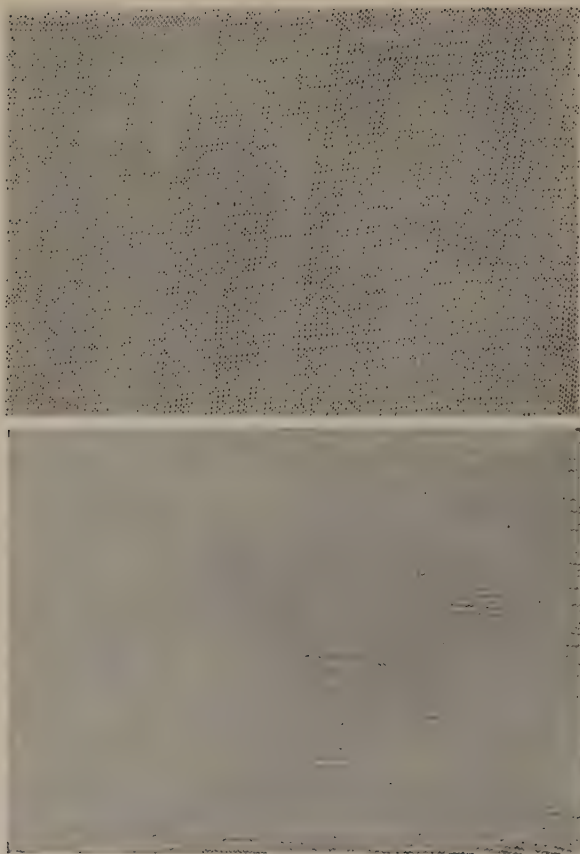


Fig. 97—36-gauge spring needle rayon fabric; face at top, back is below.

a thread that appears mainly on the back and is therefore called a backing yarn. This side of the cloth is napped to produce a pile or fleece fabric, or it may be left as it comes from the machine. Napping was formerly done on the knitting machine by severing the backing yarn and brushing out the loose ends to produce a pile or nap, but with the coming of the so-called "fleece-lined" underwear, napping machines were adapted to do this work, leaving the knitting machine to do its legitimate work. The usual

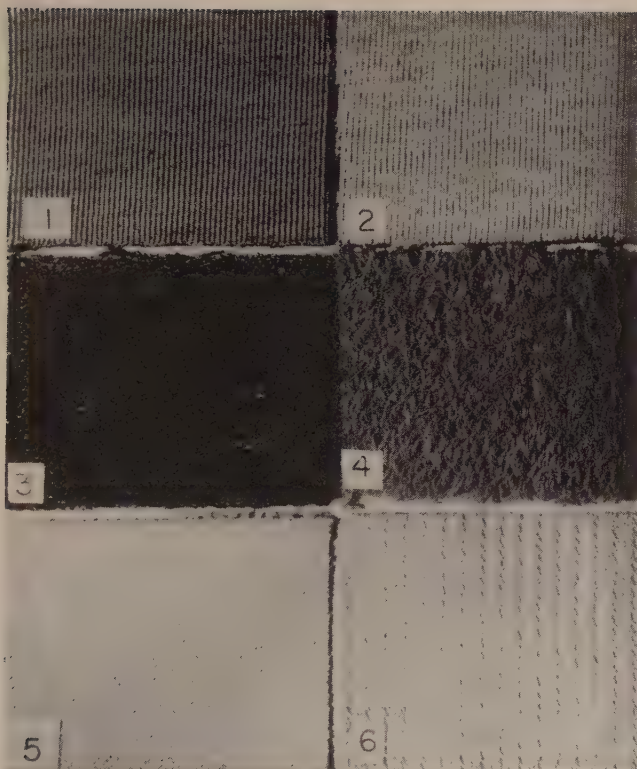


Fig. 98—Typical spring needle fabrics: (1) single plush, face; (2) double plush, face; (3) double plush, back; (4) loop terry fabric; (5) tuck stitch fabric; (6) eyelet mesh.

method of lacing the yarn among the needles is to spring back alternate needles and lay the yarn in front of them and behind the others. This causes more severe strain on the needles than ordinary knitting. Another way of getting the yarn into the needles is to bend the yarn so that it may be placed alternately in front of and behind the needles. The style of bur to accomplish this object has a plate, to which in the press places are hinged latches or sinkers which serve to hold back the yarn into the blade spaces in order to lay it in front of the needles. A stationary cam on the stand beneath the bur secures the open-

ing of these latches to allow the yarn to enter the groove in the blades, and the contact of the needle pushes the latches and the yarn behind them, into the spaces. On receding from the needles the latches open and release the yarn. This bur puts in a loose back and reduces the inward bend of the needles very considerably, though the friction slightly exceeds that of some other burs and slightly increases the strain on the needles. A close study of the relations of the burs to the needles, and their action on the yarn will reveal much to the close observer.

The needle mould used in leading needles consists essentially of two side pieces, each having secured to its inner face a plate, and hinged by a bolt at one end. The side pieces form the sides of the mould and the adjacent edges of the plates form the front and back faces of the mould. The sprue is drilled between the side pieces at the free ends, and the two needles, held heads outward by a "trick" and grooves, project partially into the mould at the hinged end. A mixture of lead, antimony, and tin that fuses readily but is quite hard when solid is poured into the mould, which is then opened, the lead with the embedded needles is withdrawn, the spruce is cut off and the leaded needles are ready to be clamped in the cylinder. One advantage of leaded needles is that the needle being held in the mould by the head and middle portion stands true in the lead and consequently in the cylinder. An objection is the bother with the mould, lead and needle boy. Faulty moulds will produce altogether too much trouble to be tolerated, and the knitter who neglects them will never excel in the art of knitting.

Needles for backing work should be longer than for plain work. The extra length prevents the sinker bur from picking up the backing. It also distributes the bending caused by the backing bur over a greater length of the needle and thereby prolongs its life.

The gauge of a leaded needle cylinder can be changed by having a needle mould made for the gauge desired, or in the case of trick needle cylinder, by having a new cylinder or trick-tops cut. The gauge determines the closeness

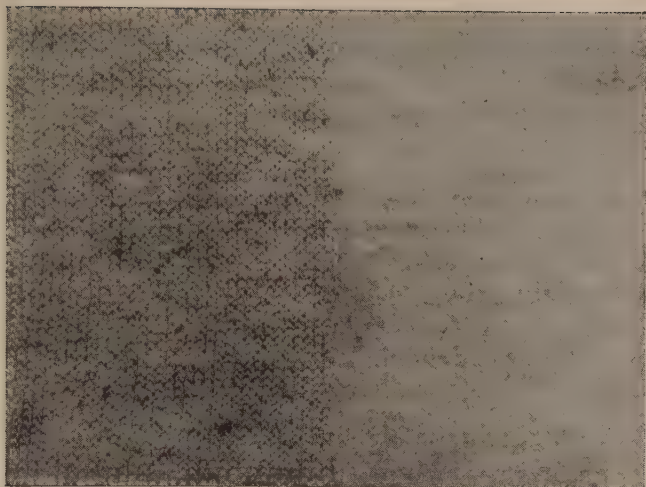


Fig. 99—Fleece-lined underwear fabric; face at left, back at right.

of the wales of the cloth and the relative fineness of the fabric. The gauge is generally determined by the number of needles in one and a half inches of the circumference of the cylinder.

If 20-gauge is required there should be 20 needles in $1\frac{1}{2}$ inches measured on the circumference of the cylinder ($13\frac{1}{3}$ needles to the inch). Or if 14-gauge is required, there should be 14 needles in $1\frac{1}{2}$ inches on the circumference ($9\frac{1}{3}$ needles to the inch). If the cylinder is 14 inches in diameter, the circumference will be 43.98 inches and if it is 20-gauge on the needle line, there will be 586 needles in the cylinder. If it is a 22-inch cylinder, the circumference will be 69.12 inches, and if it is 22-gauge the needle spaces should contain 1,014 needles.

To reduce gauge to needles per inch, multiply the gauge by two-thirds because the gauge is the number of needles in $1\frac{1}{2}$ inches. To find the number of needles to the inch, the whole number of needles in the machine and the diameter being given: Multiply the diameter by 3.1416 and divide the number of needles by the product. For example: Given a cylinder 22 inches in diameter containing 1,014 needles, how many needles are there to the inch? $22 \times$

$3.1416 = 69.08$; $1,014 \div 69.08 = 14 \frac{2}{3}$ needles to the inch; $14.67 \times \frac{3}{2} = 22$ gauge.

To find the number of needles required in the cylinder when the number of needles to the inch or gauge, and the diameter of the cylinder are given: Multiply the diameter of the cylinder by 3.1416 and multiply the product by the number of needles to the inch. Example: How many needles should there be in a cylinder 18 inches in diameter to knit 20 gauge cloth?

$18 \times 3.1416 = 56.62$ inches, circumference of cylinder
 $56.62 \times 20 \times \frac{2}{3} = 754$ needles in the machine.

Operating Speeds

Such a variety of circumstances are met in the process of knitting a fabric that no hard and fast rule for speed can be given. Some interval of time is required for the easy and perfect formation of the stitch on the needle. Wool mixtures and other soft yarns cannot be knitted with the needles running at the highest rate of speed because they are likely to break before the stitch is formed. On the other hand the hard twisted yarns for balbriggans may be knit at the highest speed because they are strong and capable of sustaining the strain and the quick sharp blows of the blades of the burs pushing, and at high speed fairly striking, the yarn between the needles in sharp bends. Before the yarn reaches the needles it lies straight across the bur spaces from one blade to another. The needle entering the space presses the yarn back between the blades drawing it over the entering blade until the full depth of the stitch is obtained. During this time the yarn meets with the resistance caused by the blades meshing into the needles behind it. This is termed "stress" on the yarn. The face yarns employed in making plush are generally very strong, and on them comes the principal stress. So many burs and wheels are employed on this kind of work that a smash at high speed would prove too serious to take the chances of high speed.

The common practice is to run a 20-inch cylinder between 40 and 65 turns per minute. This corresponds to a

needle speed of from 210 to 340 feet per minute. The following table represents some customary speeds:

		Gauge	Revolutions
20-Inch	Wool Mixtures	18	45
Cylinder	Plush	24	60
	Balbriggan	24	66

Greater speeds than these may be attained when all or most of the conditions are favorable. The machines should be run so that the needle velocity is approximately constant for all sizes of cylinders. If the machine is belted properly for a 20-inch cylinder the pulley on the receiving shaft should be of the proper size to produce approximately the same needle speed. It is also geared so that for one turn of the receiving shaft a 20-inch cylinder makes .254 turns. In other words the machine is geared about 4 to 1. Four turns of the receiving shaft are equal to about one turn of the needle cylinder. The receiving shaft should run about 240 turns which will make the cylinder run about 60 turns.

Leaded needles may be readily set by first removing the needle plates and clearing the verge or ledge on which the needles are seated, of corrosion gum, and oil. Lay the leaded needles out alongside on a board in rows, with the beards up. Put one plate in position but leave the screw loose. Pick up as many leaded needles as the plate will cover. Place them between the verge and the plate rather low down and then tap gently on the cap. They should rise easily into line. Screw the cap down gently and then square the end leads with a small square placed on the ledge of the cylinder. Tighten the screws enough to keep the leads from tipping. Replace the next plate, place the needles as before, pressing them against the preceding lot so that no spaces are left between the leads. Square the exposed end of this lot of needles. Repeat this around the cylinder. The last plate cannot be squared but the first lot will keep them from tipping. If a space is less than half a lead, loosen all the plates slightly and begin tightening on the side opposite, tapping them gently and approaching the space from both sides. This should close the space. Very little plyering should be necessary.

Trick needles require treatment similar to leaded needles with particular care that the needles fit into their places properly and completely and that they are free from dirt which would keep the needles from going into place or from oil, which would work up onto the needle and streak the cloth. Place the needles in position, replacing the needle plates as each plate space is filled. Take care to place the plates so that the needle nearest each end of the plate is securely held. When all the needles are in position adjust a stiff wire pointer from the inside plate or heart to the needle line and plyer the needles so that they stand horizontally, and so that all just touch the end of the pointer when the cylinder is revolved.

Setting the burs requires the division of the needle line into as many parts as there are to be feeds, leaving room on the front of the machine for the stop motion. These divisions may be marked by setting the cast-offs, provisionally, placing the first one just before the stop-motion so that the needles when in motion reach the cast-off before they do the stop motion. When the needle line has been divided, complete the setting of the first cast-off. The wings should reach from below the beards of the needles, but not to the base, up a little above the heads of the needles, and should run with no back lash. If the bur has back lash, tip it forward to bind it slightly. The ideal position is that in which the bur is tight enough to cast off the stitch evenly without interfering with the needles, and yet not so tight as to put unnecessary stress on the needles, thus working them in the leads or tricks. Occasional slugs in the yarn must be taken into consideration. Slugs are more difficult to cast off than the ordinary yarn. The bur should come far enough through the needles to even up the new stitches in the heads of the needles as the old stitches are cast off, yet not so far as to put undue stress on the stitches.

Bur and wheel adjustment may be properly accomplished when the functions of the burs and other parts forming the stitch are thoroughly understood. As the needles revolve, the cloth wheel presses the old stitches down to the lowest exposed portion of the needle, and holds them there while

the sinker bur runs the yarn up under the beards of the needles and while the presser which follows the sinker closes the beards at the presser, the cloth wheel or cam releases the old stitches gradually, allowing the lander to land them on the points of the beards. The cast-off follows the lander and casts the old stitches clear of the needle.

The lander is set just ahead of the cast-off. The blades should reach as low as possible without striking the cylinder or leads, and should carry up far enough to land the stitches a little above the points of the beards. It should be loose enough in the needles to run without working the needles, but not so loose that the entering blade will strike the approaching needle. This will cut the yarn or bend the needle. It is good practice to leave enough space between the lander and cast-off to permit taking the cast-off from the stud in order to clean or repair it.

The cloth wheel or cam is set just ahead of the lander so that the old stitches will be held down until the lander raises them. It should carry the old stitches down to the base of the needle without putting undue strain either on the cloth or on the needles at the front edge of the wheel.

The sinker bur is set in the needle space covered by the cloth wheel far enough from the front of the wheel to make sure that the old stitches will be carried down before the sinker is reached and far enough from the back edge of the cloth wheel to leave room between the sinker and the lander for the presser. The sinker should be set with the upper part of the entering blade inclined toward the head of the approaching needle. If the needles are moving from left to right, the bur should be tipped from right to left, and vice versa. The extent to which the bur should be tipped depends on the following considerations: In the first place the sinker blade is generally a deep blade, and but little tip is possible without interfering with the needles.

Again, the yarn is looped under the beards by the blades of the sinker and in this process the blades have to crowd the yarn between the needles and a considerable amount of force is required. The force is supplied by the needles to the bur and in doing so the needles bend a little, allowing

the bur blades to fall slightly behind their normal position and making interference likely from this cause. The position of the bur to be sought is that in which the yarn will be surely placed under the beards, looped to the required depth, and carried well up in the heads of the needles, with the least stress on the yarn and on the needles and without interference with the needles. If the bur is tipped too much it works the needles excessively and is likely to cut the yarn. If not tipped sufficiently it interferes with the needles and picks off the beards.

The presser should be set to hold the beards closed as the stitches are being raised over them. This space is just a little ahead of the center of the lander. Space must be left between the presser and the lander blades to allow the rising stitches free passage; otherwise they will be cut. When hard twisted or wiry yarn is used the flat presser is frequently used and is made long enough to cover all the beards between the sinker and the lander, thus keeping the yarn from dropping out of the needles until caught by the old stitches. Before starting the machine all bearings should be lubricated and oil cups filled.

The machine should be threaded as follows: When the available space is filled, take a bobbin of the yarn to be used, place it on its rack directly under the screw eye nearest the sinker stand. Pass the yarn up through this eye, then through the outer end of the guide and finally through the inner end. The yarn should be delivered as near to the bur as possible, and a little above the nibs. This necessitates placing the inner end of the guide close to the bur and the needles. Care should be taken that it is not so close that a slight pull on the yarn or a bunch on the needles will pull the guide against the bur and cause it to drag and break needles. After threading the guide draw the sinker bur back, pass the end of the yarn around it, and let the bur come back into position. If the edge of the fabric is ragged it should be trimmed with shears, otherwise the sinker will pick up these ragged edges and break needles. In any case the machine should be turned gradually to avoid pick-ups. Turn until more exposed needles are available, and continue

putting on the fabric. If the first feed is properly set, the old fabric will be clear of the needles after leaving the cast-off but will be held to them by a new loop on each needle. When these new stitches approach the next sinker, it must be threaded.

To start the machine take a tube of knit fabric, preferably of about the width of the fabric to be made, and of the same or finer gauge. Pass it over the take-up rolls so that it will be rolled up when the take-up is in action. Throw out the ratchet so that the fabric may be drawn down over the spreaders. Then throw in the ratchets in order that the fabric will not descend further. Select the needle space that is freest from obstructions, generally the stop motion space, and press the fabric near its edge down over the needles until the beards catch and hold it from coming off. Begin putting the fabric on near sinker bur and continue in the direction opposite to the direction of rotation.

When the fabric is on all the needles, turn the cylinder once or twice by hand and then examine the new stitches. It will generally be found that in some cases one stitch straddles two needles making a drop stitch effect. Hold down the fabric at this place. Press down the beard of one of the needles and let the stitch off of that one. At the next bur the stitch will form properly. If the sinkers are not set deep enough, the stitches will be too tight and will break. If the pressers are not pressing enough the needles will load up. This will occur even when the pressers are deep enough if some of the needles are bent inward. If the cast-off is too high it will break the stitch in casting off. If it is too low it will not even up the stitch in casting off and the fabric will not look well. Correct all these defects and see that everything is running free and the take-up is working properly before putting on the power. In putting on the power, let it be for half a turn at a time, and be alert for trouble. A bent needle or a bent blade, a rough bearing, a misplaced guide, any one of many little things may let the fabric off the needles or break a lot of needles if caution is not used in starting. If half a turn with power discloses no trouble, try a whole turn or more, feeling the fabric frequently to

make sure that it is being taken up properly. If the tension is too severe it will finally pull the fabric off the needles, and if it is not enough, the push-downs cannot keep it clear of the sinkers and a smash will result.

After running several inches of fabric, stop the cylinder and look for defects. A high beard will make a long stitch or a tuck. A bent needle will make a line. Needles out of line will make a vertical streak of tight or loose stitches depending upon whether displacement is inward or outward. A short needle will make a line. Remove defective needles.

The stitch should be synchronized by marking each yarn one foot from the guide, turning the cylinder slowly and noting which marks reach the guide first, and shortening the corresponding stitches or lengthening the others. Continue this until all the yarns feed alike.

The stop motion should be adjusted before letting the machine run. The stop motion should be adjusted so that the feeler will enter a hole and stop the machine. Some stop-motions have a waste claw. This should be adjusted near to the needles to catch bunches or thread that stay on the outside of the needles. The stop motion spring should be adjusted as lightly as possible without making it stop the cylinder unnecessarily. If the spring is set hard it will enlarge the holes and sometimes bend the needles at the same time.

Adjusting for Specific Types of Cloth

Plated work has one kind of yarn on the face (the inside when on the machine) and another kind of yarn on the back. It may be made by using a guide with two sets of holes to accommodate the two yarns. The face yarn is the upper one delivered to the bur. When two threads are used each should be equivalent to about half of the weight of the single thread used for fabric of the same weight and gauge.

A better method of plating is to use two sinker burs to each feed and deliver the face thread to the first sinker in

order of rotation, making the stitch of this bur longer than that of the following one. The difference in stitch depends on circumstances, but from one inch to the foot to 1½ inches to the foot is usual. Plated work with two burs has some marked advantages over single thread work. A nice appearing garment may be made with expensive stock in the face and cheap stock on the back. The sinker burs divide the work between them and make a more uniform stitch and are less likely to overreach than when one bur is used. The fabric is generally stronger. It is durable and it runs well. If a yarn breaks the fabric does not leave the needles as in single thread work.

Designing for the knitting machine is similar to designing for the loom. It is obvious from the foregoing that if four feeds and four different colored yarns are used, the fabric will be striped horizontally in a pattern containing the four different colors, and this pattern will repeat itself at every revolution of the cylinder. By increasing the number of feeds, the width of the pattern and the number of colors may be increased. From this and from the construction of the machine it is evident that changes in the yarn effect the fabric horizontally or across its length, and that vertical or lengthwise effects must be caused on individual needles, for the fabric rises vertically from the needles.

Now suppose that the cylinder is set up with but one feed, this feed having a round presser, and suppose the presser has been nicked on a miling machine so that the nicks correspond to the needles and so that each succeeding needle comes to each succeeding nick. The result will be plain fabric just as if the presser were not nicked, but the presser will make a certain number of revolutions to each revolution of the cylinder. Suppose that the cylinder has 600 needles and the presser has 100 nicks. The presser will revolve six times to one revolution of the cylinder. Suppose one nick is cut deeper than the others so that the needle which enters it is not pressed. Then every hundredth needle will not be pressed, and at every turn of the cylinder a tuck stitch will be left on each of these six needles. If this were allowed to continue each of these six needles would load up

and break, for a new stitch would be placed under the beard at every turn, and not being pressed off they would be retained there. The tuck stitch is desired in order to get a vertical effect in the cloth. Possibly one tuck is required, or two or three, as the case may be, but it is not desirable to injure the needle, so at intervals this must be pressed off. It may be done in two ways. Another feed with a plain presser may be added or a needle may be removed. Suppose another feed with a plain presser is added. Then every hundredth needle will have a tuck stitch as it passes the cut presser and all the needles will be pressed at the next feed. The result will be a fabric in which every hundredth stitch in every other course is tucked. These tuck stitches will occur in a vertical line at every hundredth needle. The width of this pattern is 100 and its height is 2.

The pattern is

Press 99	Skip 1	Cut Presser
Press	100	Plain Presser

If the plain feed is removed and the original cut presser feed is used, this will load up every sixth needle. If one needle, however, is removed, then at every turn of the cylinder the skipcut will step one needle ahead. The needles that were skipped at one revolution will be pressed the next revolution and the tuck stitches will take a diagonal course of approximately 45 degrees inclined to the right upward, as the fabric is viewed on a machine that turns from left to right (anticlockwise). If one needle had been added instead of removed, the diagonal would have been inclined to the left, as the presser would then step back at each revolution of the cylinder. At every hundredth revolution the skip space would be back to the needle where it started.

A similar result would be obtained by leaving the needles as at first, 600, and making one more nick in the presser, or taking one out. The effect of this would be to step forward or back one needle at every hundredth needle, one needle at the first hundred, two needles at the next, etc.

The above are the fundamental principles of tuck presser work. It is customary to run a plain presser after each cut

presser for the ordinary forms of work, but of course, any combination may be used. To show how the pressers should be cut for any desired pattern, take a piece of cross-section paper having as many vertical spaces as there are needles in the pattern and as many horizontal spaces as there are courses. Number the horizontal rows of spaces to correspond to the pressers. For instance, if there are four pressers, number the horizontal rows 1, 2, 3, 4 and then repeat 1, 2, 3, 4 to the end of the allotted space. Then mark the squares to be tucked. When all are marked the pattern for any one presser may be read on the lines numbered to correspond to it. Read for No. 1 presser the first line. Then the next, and so on. If pressers 2 and 4 are plain their pattern will be press all.

Collarette requires a considerable amount of plain work between the tuck work and an automatic device is used to substitute plain pressers for cut pressers without stopping the cylinder. A popular collarette combination is three tuck pressers in unison (three tucks on the same needles) followed by two plain pressers. The pattern is generally "press one, skip one."

Backing cloth, including single plush and double plush, is plain knit fabric with a thread or yarn caught in the stitches but not forming stitches itself. Backing cloth may be made with a sewing needle by taking the common or "flat" fabric, and running a heavy basting thread across it, making the courses close together. If this basting thread were then napped into a fleece, the fabric would be "fleece-lined," and it would be single or double plush according as the original fabric was single thread or two thread. The word single or double applies to the face and not to the backing. If the backing thread were a material that would kink and curl after knitting, the material would be astrakhan, or boucle cloth.

On the knitting machine the backing is put into the fabric by lacing it among the needles before the face thread or threads, if two are used, are looped under the beards. The backing is not placed under the beards and does not go there. Suppose for simplicity the machine is set up for flat

work with only one feed, and that the one feed has been running and making cloth. Now suppose that a comparatively heavy but loosely spun yarn is taken, and beginning just ahead of the sinker, where the fabric is held down, is laced in front of one needle and in back of the next two and so on, working from the sinker bur. Suppose that this yarn is pressed down to the base of the needles, so that the sinker will not pick it up, and that the cylinder is slowly turned in order to get more needle space in which to lace the backing. If this is done the flat fabric will be transformed to single plush.

It will be noticed that the three requisites to make the changes were space in which to lace the backing on the needles (for the fabric must be held down before the backing can be placed in), means of lacing the backing thread, and means to carry the backing thread down clear of the sinker. To get the space the push-down must be long enough or of sufficient diameter to give the space, and the sinker and presser should be set pretty well back in respect to the push-down. To lace the backing in the needles a bur similar in shape to a sinker is used, but larger and with a deeper nib and the reverse angle. This bur is blocked so a needle will be pushed back at intervals and the backing will be placed in front of the needle so pushed back and back of the other needles. This bur will not carry the backing down far enough to clear the sinker, so a clearing bur is put between the backing bur and the sinker. The clearing bur is like the cast-off, but since it is on the outside of the cylinder, it works downward instead of upward. A combination of this kind—a backing and clearing bur preceding a plain feed—makes a single plush feed. As many such feeds may be used as the cylinder space will allow.

To make a double plush feed, remove the cast-off from the single plush feed, and bring another complete flat feed up close to the single plush feed. With this arrangement the backing thread is brought up to the heads of the needles between the two feeds and is held there by the first face thread which is called the binder, because it binds the backing. In double plush the backing does not show on the face as in single plush.

Sinker Bur

The sinker bur is an angular gear having as teeth tempered steel blades with a slight hook, called a nib, for controlling the yarn during the operation of pushing it between the needles and up under the beards. The bur body is generally made of bronze to facilitate cutting, and is provided with a hardened steel bushing to insure against sticking, to provide for long wear and to enable replacement. The blades are radial and straight (plane), so the length of stitch is limited. For this reason good design and adjustment are necessary for good running work. Moreover, they are not adjustable, so the operator has no choice regarding the space of the blades. .

The operator can adjust the bar in and out, up and down. He can rotate it on a horizontal axis, and can generally throw the top of the bur in or out of the needles with respect to the bottom of the bur to a slight extent.

The bur bends the needles backward with the reaction of being driven, and pushes the needles inward with the reaction of feeding the yarn. If the needles are displaced too far, the bur over-reaches and the blades get in under the beards, which causes serious trouble. If the inward bend of the needles were slight and constant, no trouble would result; but it is not constant because it depends on the pressure of the yarn which increases with an increase in yarn diameter or an increase in tension. Consequently there is always some variation in the inward bend of the needle, since the yarn tension is never constant, and since the diameter is seldom uniform except in the very best yarn. Evidently, inward bending of the needle shortens the length of the loop drawn in proportion to the extent of the bending, and makes cloudy fabric. This inward bend of the needle, which causes defective fabric, and this backward bend, which causes broken needles and other waste, are the two most serious objections to the loop wheel machine. Together they do much to offset the advantages of high speed, durability and adaptability to change of size, gauge and kind of work. Moreover, there is the still further

disadvantage that a poorly designed or improperly adjusted sinker aggravates the troubles just mentioned.

The diameter of the sinker bur should not be greater than is necessary to enable driving it with security and still to get the yarn surely under the needle beard and leave the loop fully drawn in the head of the needle. There are different opinions as to how far below the point of the beard the yarn should begin to draw the loop. If a low point is selected, the drawing is facilitated by the round shank of the needle; but a low point needs a large bur, which increases the backward bend of the needle. If the drawing of the loop is begun well up toward the point of the beard, the diameter of the bur must be less, but there are the disadvantages of drawing over the needle eye, which extends down a little way below the point of the beard; the possibility of splitting the yarn on the point of the beard, which causes a partial tuck; and the possibility of feeding it up over the beard, which causes drop stitches or a press-off. Evidently with a short stitch, the diameter of the bur must be large in order to have enough blades in mesh for secure driving, and in order to obtain sufficient lift for the yarn. On the other hand, for a deep stitch a small diameter is advisable, since the lift is increased by sinking the bur deeper, and since a large bur would put so many blades in mesh that it would cramp itself. Consequently, the length of stitch to be run has much to do with determining the diameter.

Theoretically, the blades should be helical, so that when in mesh they would be nearly parallel to the needles. English sinker burs with soldered blades are sometimes made this way by bending the exposed portion of the blade, but since such bending is practically impossible with the well-tempered blades called for by American practice, and since the cutting of narrow helical slots and bending of blades to correspond is not deemed practical helical blades are not used in American practice. Consequently, a part of the freedom of the bur in the needles is lost through the difference of inclination of the blades in mesh. From this it follows that the action of the bur in the needles may be

made freer by reducing the vertical height in the needles, which may be done by bending the sinker bur bracket upward in machines where flexible brackets are used, or by packing the sinker stand outward where no such provision is made.

However, there is an objection to reducing too much the vertical height of the blade in mesh, since this reduction increases the danger of over-reaching; as is seen from consideration that the bur, although like a gear, has a large amount of back lash (play, in the needles) as compared to a gear. This back lash is reduced by tipping the bur so that the tops of the blades are inclined backward with respect to the motion of the needles. This tipping brings the rounded part of the blade where it will strike the approaching needle in case of a pull back, and will help to keep the bur in mesh, instead of allowing the nib of the bur to over-reach and shear off a needle beard, in which case it is likely to continue to over-reach until the machine is stopped and the bur is reset. If the blade has insufficient vertical depth in the needles, the bur cannot be tipped enough for secure running. This gives a clue to one of the most important points in setting a sinker. That is, that the shoulder of the blade should enter near the approaching needle, whereas the nib of the blade should enter near the passed needle when the bur is set at the required depth. It is advisable to try this before putting in the yarn as well as after. When this requirement is met, the nib should leave the loops in the heads of the needles and should retire without pulling the loops and without touching the needles. If it does snap the needle on either side, the loop is almost sure to twist or drop and moreover to make rough work, by the formation of unequal stitches.

It is well to adjust the bur and run the machine without yarn or cloth in order to observe the action of the bur, which should run uniformly without grating the needles, without bucking them as the blades enter, without rippling them as the nibs retire and with but slight bowing action opposite the center of the bur. If the shoulder bucks the needles, the bur may be too coarse, or the top may be

tipped backward too far. If it bows the needles too much, it is said to be gathering them, i.e., pinching them together. This is undesirable, since the yarn cannot be fed freely, so that weak places are likely to part at the sinker and knots are likely to catch, either of which often breaks the yarn. If the needles are rippled by the retiring nibs, the indication is either that the bur is coarse and is pushing the leaving needle forward, or that the bur is fine and is holding back the oncoming needle. This last fault is worse than the first, since if the bur is tight without the yarn, it will be still tighter when it is feeding the yarn, because the considerable force required to draw the loop has to be transmitted by the flexible needles, which bend backward some, and so permit the leaving nib to "pick" the oncoming needle still more; whereas if the leaving nib is pushing ahead slightly when it is running without yarn, it may be drawn back into its proper position when the yarn is being fed.

If the bur runs properly without the yarn, it should then be tried with the yarn, either when the cloth is not on the machine, by turning the cylinder by hand, or by trying it with the cloth and power on. This depends on the skill and experience of the operator and on the yarn and stitch used. Some adjusters use a magnifying glass and make exhaustive tests before putting on the power. Others, especially with light yarn, will put a sinker on the stud, throw on the power, and make all adjustments with the machine running at full speed. The best way is undoubtedly to set the bur as carefully as possible before the power is on, make sure that it forms the loop freely and properly and then observe it when it is run with power. The action of the needles in mesh should be noted by inspection from above their heads. They will bow inward more than when the bur was running free and the extent of the bowing will fluctuate according to the tension on the yarn and the lack of uniformity in its diameter. But the general shape of the needle line in the bur should not change to a considerable extent. If it does so, becoming almost angular at times, then there is a cramping action which should be eliminated if possible.

There are many causes for this violent pushing-inward

of the needle. The yarn has to be dragged over the blades and around the shanks of the needles with a velocity which varies from one and one-half times that of the needles, at the entrance of the yarn, to zero velocity when the loop is fully drawn. The extent of the dragging, sliding, and rubbing is seldom realized. But some conception of it is necessary in order to understand how to reduce it.

The edges of the blades may be too sharp. Theoretically, they should be half round, but practically they are not so, since in the punching one edge is slightly rounded and the other is left with a sharp fin. In the subsequent tumbling the already rounded edge becomes still more rounded, but the sharpened edge does not always get enough tumbling to bring it into proper shape. Consequently, even when the edge is smooth, it may be angular enough to retard the yarn unduly and thus increase the work of sinking the loop. If in addition to this the roughness is not taken off the edge of the blade, the case is bad indeed, for the work of sinking the loop will not only be much increased, but the yarn will be scraped and cut, especially at knots; and an occasional leaving nib will pull a long loop by stealing from the already formed loops, and will thus make a loose loop on the back of the fabric with tight stitches on each side, which latter are likely to get cut at the cast-off.

Blades which are improperly tempered may appear all right, but may become nicked with use, and so may act as if improperly tumbled. Sometimes during the hardening of the blades a black oxide forms and does not come off in the tumbling. The roughness of this oxide will sometimes put severe friction on the yarn.

Needles which are rusted, tarnished, or insufficiently polished will sometimes put so much tension on the yarn that the sinker will appear to be improperly set. Also, needles which are cramped too tightly, or are roughened in the cramp by improper milling or by oxidation, will resist the entrance of the yarn. The resistance increases the inward bend of the needle, which in turn increases the cloudiness of the fabric and invites "smashes."

If the sinker runs all right with the yarn in position, it

should be tested for a slight overload, which testing is generally done by turning the cylinder with one hand while a finger of the other hand is held on the bur to retard it slightly. If it is properly set, it will strike the oncoming needle first with its shoulder. If it is improperly set, the nib or the whole edge of the blade will catch and buck the needle out of line inwardly. It is unsafe to run a bur set in this manner since overloads are certain to occur, and a bur so set will neither avoid trouble nor extricate itself, but will get into deeper trouble after it gets started.

If the sinker withstands a reasonable overload, the next consideration is the sinker shaft spring. All machines are provided with this, for the reason that by retention of the adjusting nut against the stop it provides in combination with the nut a convenient means of adjusting the bur for depth. Moreover, probably the majority of knitters consider that the spring is useful for relieving the sinker when a load-up occurs, by allowing it to back part way out of the needles. Consequently, the spring is generally adjusted to keep the bur at the required depth under ordinary circumstances, but slack enough to allow it to back out and drop its load if this gets so heavy that serious damage would result. Of course, if the spring is too slack, it may allow the bur to back out and shorten the stitch unnecessarily, which is the fault with the use of slack springs. However, it is generally admitted that for good speed and especially with fairly heavy yarn, much damage can be avoided by careful adjustment of the spring.

A common difficulty with sinker burs is to get blades of the proper thickness. Bad results follow the use of blades which will not go down into place as well as blades which are loose. If it is necessary to use blades which are slightly oversize, they can sometimes be assisted into position by boiling both the blades and the bur bodies in a solution of washing soda. On the contrary if the blades are very loose, they should not be used at all, since they will make serious trouble. If they are slightly loose and no others are available, the bodies may be put on an arbor and filed slightly

with a dead smooth file, which will throw a slight bur over into the slots so that the blades will fit nicely.

The Lander Bur

The lander bur follows the sinker and raises the old stitch up on the point of the beard while the latter is held into the eye by the presser. Adjusting the lander may be understood by considering its location. It runs closer to the leads—or cylinder if a trick-needle machine is used—than any of the other stitch-forming burs, since it is necessary for it to reach low in order to raise the old stitches surely, instead of punching through the fabric. On the upper side it comes very near to the presser, since it has to land the stitch while the beard is sunk in the eye. Raising the stitch earlier will make tuck stitches and raising later will not complete the new stitches. Moreover, the needles in the location of the lander must not only drive the lander, but must also withstand the resistance of the presser, which holds them inward and backward a little. Consequently, the needles cannot be depended upon to keep their proper position, especially with a short stitch, which puts considerable work on the lander and on the driving needles. The requirements show that the lander should run as near as possible, without touching, to the leaders or the cylinder (as the case may be), and as near as possible to the presser without touching it and allowance should be made for deflection of the driving needles inward and backward. The necessity for this allowance accounts for the popular rule to set the bur loosely because if it is set tight, the displacement of the needles will still further tighten it. However, it is evident that if the bur is too loose, it will overreach so that the end of a blade will buck the oncoming needle. The point of contact is low on the shank of the needle where it cannot give very much, so the result is either bruising of both the needle and the end of the blade, bending outward of the needle, or breakage of the blade. The bruising causes tearing and cutting of the yarn, the bending outward of the needles destroys their alignment in

a manner which is readily recognized, since needle displacement is generally inward and a broken lander blade generally causes a tuck stitch whenever that blade comes into action.

One of the most frequent sources of cutting is a rough lander blade. One reason for this is the facility with which it can be roughened, owing to its proximity to the presser and to the rigidity of the needle with which it interferes. Sometimes a thread of waste winds around the lander stud and raises the bur so that it interferes with the presser. This causes a peculiar grinding sound when stationary pressers are used, but nicks and raises a round brass presser. The nicking of the brass presser is likely to be manifested by the appearance of tucks or cuts, whereas the raising of it prevents clearing the old stitches, and, consequently, leaves the yarn floated on the back of the fabric instead of being knit.

A loose lander stud will sometimes allow the bur to take a sudden dip into the leads, in which case a blade is likely to be broken out. Also a weak lander bur support is likely to spring downward under the load at full speed, and to allow the blades to interfere with the leads or the cylinder according to whether leaded or trick needles are used.

The Cast-off Bur

The cast-off bur raises the old loops from the swell of the beards, where the lander left them, up and off the heads of the needles, which is the stitch-finishing operation. This duty is much like that of the lander's, but it is favored by unrestricted space, which allows large diameter of bur, and affords the added advantage of more blades in mesh for secure driving. Still more, the cast-off blades may be set farther through the needles which also provides security. There is an offset to this in that the cast-off works near the tops of the needles where they are most pliable. But altogether the cast-off is considered the easiest bur to set; or, if it is well set, it is the least troublesome.

The common rule is to set the cast-off tight, since the backward bend of the needles in action loosens the cast-off

less than the lander. The ideal position is supposed to be that which allows the entering blade to keep close to the forward needle, since this provides space for a backward pull under an overload, and allows the leaving blade to withdraw midway between the adjoining needles. Evidently to obtain this, the driving must be done against the blades which are well in mesh, which requires good design and correct adjustment. The absence of either of these puts so much work on the leaving needle that it snaps free with a force that vibrates it like a tuning fork. It is likely that this vibration shortens the life of the needle. Some knitters believe that in time it snaps the beards off. But at least, excessive pressure is likely to shear the yarn, especially at knots, by pinching the loop between the blade and the head of the needle.

The cast-off blades like those of the lander have a draw-cut action, so cutting is likely if they are sharp or nicked. Consequently, every precaution should be observed to get good blades with which to start. After that the principal cause of nicking is twisted beards. The cast-off blade, entering as it does from behind the needle, cannot get into the eye, neither can it get under the beard unless the latter is bent considerably to one side. But it is sometimes bent so by the sinker. The result is that the rising cast-off blade, entering between the beard and the shank, forces the beard off and nicks itself so that every time it touches the stitch it cuts some or all of the fibers.

The cast-off burs generally used in America have rounded points, which permit the blade to slip past a load-up, particularly if the needles spring outward to assist so doing. This method of casting off evidently lacks the positiveness of cast-off jacks, so the fabric from loop wheel machines frequently lacks uniformity through this somewhat haphazard method of casting off, unless other means are used for securing equal stitches. A rotary cast-off bur with a positive action simulating that of cast-off jacks is used to some extent, but it requires rather short needles in order to obtain a sufficiently positive drive to perform the harder work which it has to do.

The cast-off is supposed to be set sufficiently high to clear the stitches surely, and yet without cutting the stitch or causing one loop to steal from another. If it is too low, some stitches will not clear sufficiently, which causes very irregular fabric, or may not clear at all, which causes tucks. If the cast-off is too high, it will strain the stitches so that a cut will occur at a weak place in the yarn or at a rough place in the blade; or if not so high as to cut, the strain on the stitch may be sufficient to make the new stitch draw some yarn from the loop ahead, which stitch in its turn will do the same; but since the amount of yarn thus drawn is variable, the stitches must be irregular.

SPRING NEEDLE DIMENSIONS AND DATA

1	2	3	4	5	6	7	8	9	10
Gauge	Dia.	Length	Beard	Cramp	Needle space gross	Needle space net	Sinker blade thick- ness	Space between needle and blade	Yarn space ($\frac{1}{2}$ of 9)
5	.1200	2.30	.70	.060					
7	.0800	2.10	.70	.050					
8	.0570	2.00	.65	.040	.1971	.1401	.020	.1201	.0600
10	.0510	1.85	.55	.030	.1562	.1052	.020	.0852	.0426
12	.0475	1.70	.53	.027	.1290	.0815	.020	.0615	.0307
14	.0415	1.70	.51	.023	.1102	.0687	.020	.0487	.0243
16	.0390	1.57	.48	.020	.0961	.0571	.016	.0411	.0205
18	.0355	1.48	.40	.016	.0852	.0497	.016	.0337	.0168
20	.0315	1.48	.38	.016	.0766	.0451	.016	.0291	.0145
22	.0290	1.48	.36	.013	.0696	.0406	.010	.0306	.0153
24	.0280	1.45	.32	.012	.0636	.0356	.010	.0256	.0128
26	.0260	1.31	.32	.009	.0586	.0326	.010	.0226	.0113
28	.0260	1.40	.30	.006	.0544	.0284	.009	.0194	.0097
30	.0230	1.31	.25	.004	.0508	.0278	.009	.0188	.0094
32	.0220	1.28	—	—	.0476	.0256			
34	.0220	—	—	—	.0447	.0227			
36	.0200	1.17	.24	.003	.0422	.0222	.006	.0162	.0081
38	.0190								
40	.0190								

The table above is based on average needle dimensions from a prominent spring needle manufacturer, and on average blade thickness of a prominent loop wheel machine. Both the needle company and the machine company emphasize the quite well-known fact that there are but few if any recognized standards for needle and sinker design. Therefore, this table is not to be taken as final, but rather as an initial basis from actual practice, with the help of which more refined tables may be made after the principles of needle and sinker design are better understood.

APPROXIMATE WEIGHT IN POUNDS PER THOUSAND OF
LEADED NEEDLES FOR SPRING NEEDLE LOOP
WHEEL MACHINE

Gauge	Pounds	Gauge	Pounds	Gauge	Pounds
12	15.0	20	8.1	28	5.7
14	11.7	22	7.3	30	5.4
16	10.2	24	6.6	32	5.2
18	9.1	26	6.1	34	5.0

Chapter VIII. Principles of Design for Spring Needle Fabrics

IN constructing designs on all classes of filling-knit flat fabrics, a combination of plain and tuck stitches is widely used. Some designs are made with a float stitch, and a few small and limited patterns are made with a laid-in or backing thread, but in pattern work for outerwear, at least, the tuck stitch is of first importance. The mechanical means of forming tuck stitches may vary with the type of machine and type of needle used, but the principles of design are the same. In other words, if a particular design is to be reproduced, certain elements must remain fixed, regardless of the type of machine used to reproduce it. The circular, leaded-type, spring needle machine is taken as a basis in this discussion, and terms used will apply to that type of machine. A cut presser is used as a tucking element, and this provides a very efficient and competent means of producing the desired effects. In general practice, not more than three to four wales are tucked consecutively; and a stitch held for four or five courses on the same needle is the practical limit lengthwise of the fabric. Anything in excess of this places an undue strain on both the needle and the yarn. It also distorts the fabric to a greater or lesser degree, depending upon the number of wales, and courses tucked.

The design area is not fixed and may be varied to suit the desired pattern. Patterns are made with little difficulty, and are limited only by the size of the jack pressers and the number of feeds which it is practical to use. An exact number of needles is a necessary requirement, and this is sometimes a limiting factor when the gauge and cylinder size also have to be exact. It is usually possible, however, to change the design slightly so that it will divide correctly into the total needles, yet not alter it enough to affect materially the shape or size of the pattern.

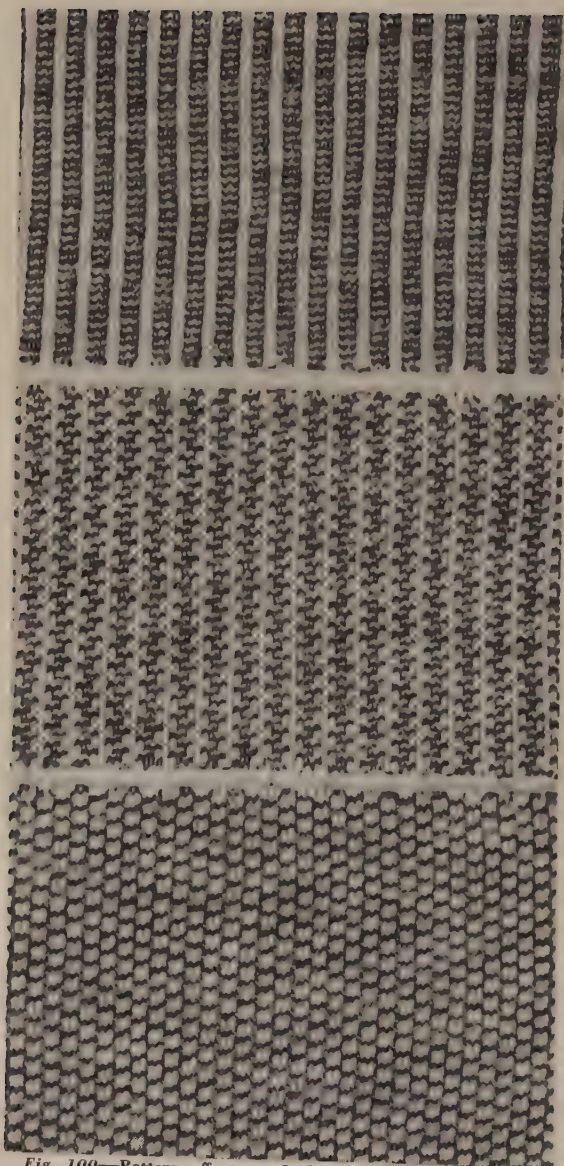


Fig. 100—Pattern effects made by varying the position of one jack presser on a two-feed machine with respect to the other presser.

In originating a design, there is one factor which is rather difficult to estimate before the pattern is set up on the machine. A design as laid out on paper may have an entirely different appearance after it is knitted. This variation is

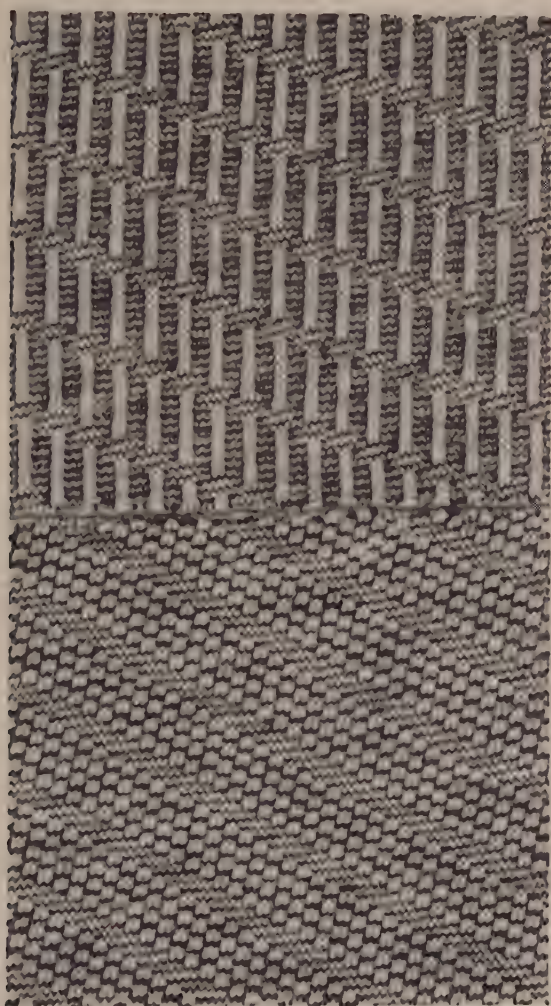


Fig. 101—Patterns produced on a two-feed, 28-gauge, 18-inch spring needle machine with two jack pressers.

caused by fabric distortion due to the tuck and plain-stitch combination.

The fabrics illustrated in Fig. 100 show the variations possible without changing the needles or the cuts in the presser. These patterns were all made by using two jack pressers both cut alike (two and two). By varying the position of these pressers with respect to their engagement with the needles, these different effects were produced. Many more small-figured effects might be added to these by small additional changes in the pressers, needles, feeds, and their combinations.

Another example of a decided difference made in the appearance of a fabric by a slight change in the machine set-up is shown in Fig. 101. The diagonal effect was obtained by changing the pattern wheels from knit 2, tuck 2, to the following:

Knit	6	2	2	2	
					Repeat 6 times.
Tuck	2	2	2	2	

While not extensively employed for patterns, a colored backing yarn may be combined with a face yarn to give a design where weight is desired. In this case the backing yarn may serve the double purpose of giving a pattern and adding weight. Since the face yarn is much finer than the backing, the colored backing shows through the face at the tie-in points, and produces the effect of a pattern. A backing thread is not classed as a stitch thread, but is simply a laid-in thread, commonly used to obtain the required weight in the fabric and to give a particular finish on one side of the cloth. A combination of backing wheels and cut pressers is sometimes used to give decidedly different characteristics to the sides of the fabric. The back can be given a napped finish, while the face will be smooth and show the pattern.

Another variation is produced in men's overcoating. The difference from the last mentioned classification is in the weight, type and size of yarns used, and the finish of the cloth. Although many overcoatings are plain, there are also those which have patterns worked on the face. The ordinary

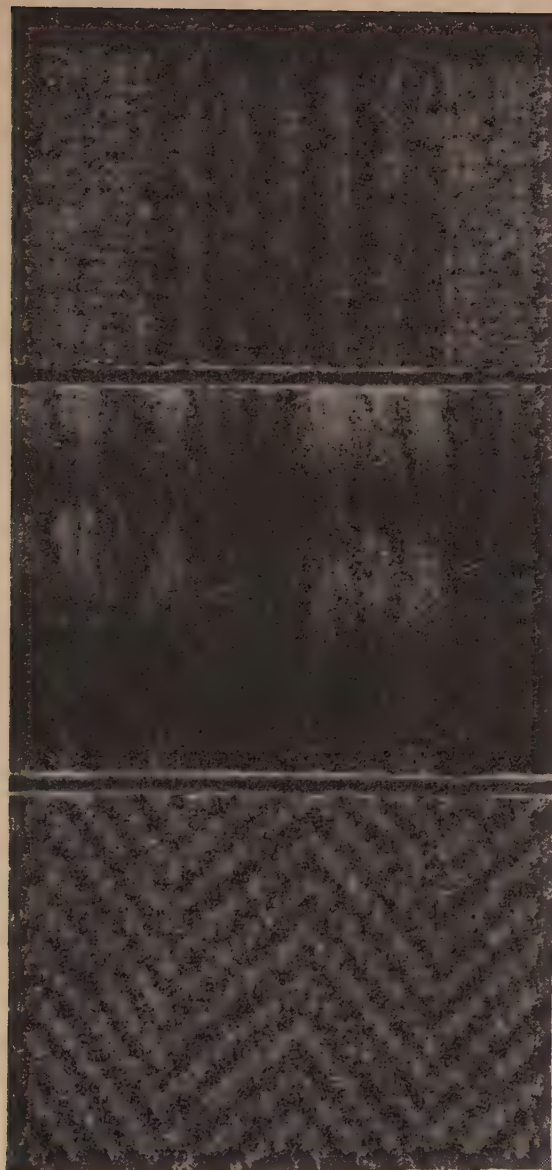


Fig. 102—Knitted overcoating fabrics.

herringbone is probably one of the best known designs in heavy fabrics for this purpose. Topcoatings follow the same lines as overcoatings, but of course are lighter in weight and do not employ a backing yarn, since their weight does not require it. Fig. 102 illustrates some types of topcoatings and overcoatings.

Principles of Design for Tuck Stitch Patterns

In planning tuck stitch patterns it is necessary to consider the number of needles in the machine and the relation of this number to the number of cuts in the pattern wheel. It should further be pointed out that in the manufacture of the machine, the mathematical relationship between the needles in the cylinder and the cuts in the wheel should be a value which will provide as wide a range of patterns as possible. In general, the number of cuts in the wheel should not be a factor of the number of needles but should leave a remainder which is a factor of the number of cuts in the wheel and in some cases of the total needles in the cylinder. Assume for illustration, a machine with 1,000 needles with one feed equipped with a 110-needle pattern wheel. The pattern width may be determined by use of the following formula:

$$\frac{N}{P} = T + R$$

where N is the total needles; P, the number of cuts in the pattern wheel; T, the number of full turns of the pattern wheel; and R is the remainder.

$$\frac{1,000}{110} = 9 + 10, \text{ Remainder.}$$

The remainder, 10, is thus the pattern width.

$$\frac{110}{10} = 11 \text{ Courses, the pattern depth.}$$

The design area would then be 10×11 .

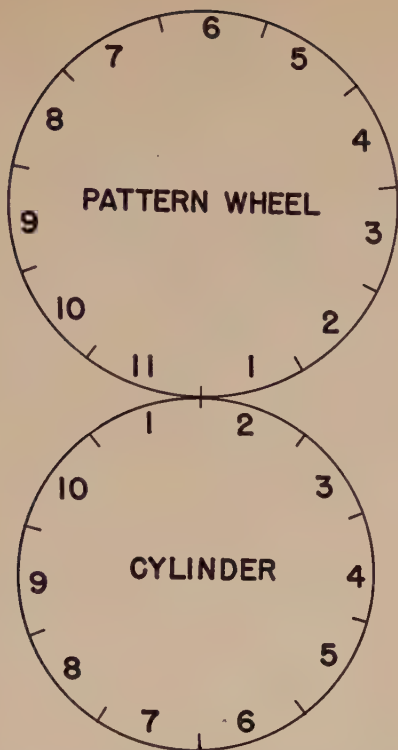


Fig. 103—Illustration of a 110-cut jack presser wheel containing 11 pattern divisions, and the manner in which they register with ten pattern divisions on the cylinder of a spring needle knitting machine.

Fig. 103 illustrates, by use of two circles, the relationship between the cylinder and pattern wheel. For convenience in drafting, the dimensions of the cylinder has been taken as 100 which contains ten pattern divisions instead of 100 which would be contained in the 1,000-needle machine. The illustration shows that on the second revolution, pattern division 11 will be brought above pattern division one on the cylinder. This overlap of ten needles will cause the pattern to be formed as a spiral upward to the right as illustrated at Fig. 104. In drafting, a rise of one course in ten pattern divisions is indicated. This illustrates the

1	2	3	4	5	6	7	8	9	10	
2	3	4	5	6	7	8	9	10	11	
3	4	5	6	7	8	9	10	11	1	
4	5	6	7	8	9	10	11	1	2	
5	6	7	8	9	10	11	1	2	3	
6	7	8	9	10	11	1	2	3	4	
7	8	9	10	11	1	2	3	4	5	
8	9	10	11	1	2	3	4	5	6	
9	10	11	1	2	3	4	5	6	7	
10	11	1	2	3	4	5	6	7	8	
11	1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	10	
					7	8	9	10	11	

Fig. 104—Graphic representation showing the effect of the combination in *Fig. 103* on ten pattern divisions or design columns.

effect which would be produced in a tubular fabric and in using this method, the paper may be cut and pasted into the shape of a tube or cylinder to get the true effect in fabric.

In preparing a design, a piece of cross-section paper should be used. In *Fig. 105* an area of 10 by 11 has been used. A small diamond pattern has been laid out in which the shaded squares represent tuck stitches. The 110-cut pattern wheel would be built by beginning at any convenient

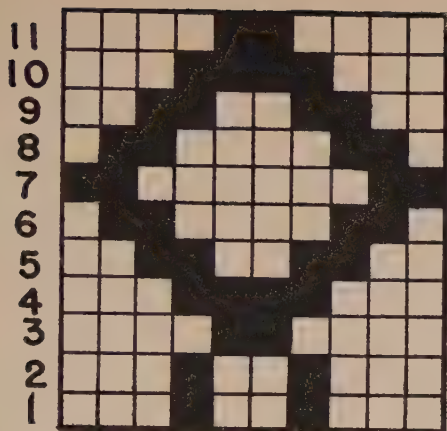


Fig. 105—Tuck stitch design on ten wales and 11 courses.

point on the wheel and following the lines of the design, Fig. 105, from 1 to 11; inserting jacks in the wheel for all blank squares and omitting them for all shaded squares. Fig. 106 illustrates three complete repeats in depth, over ten pattern divisions or design columns.

An interesting example is illustrated at Figs. 107 and 108. The pattern at 107 is a herringbone effect produced on an 880-needle machine with one plain feed and the other equipped with a 120-cut jack presser. The design area was determined by dividing 880 by 120 which gave seven complete repeats of the pattern wheel for each turn of the cylinder with a remainder of 40. Forty is a factor of both 880 and 120 and is contained in 120 three times which is the pattern depth. The point paper design layout is shown below in Fig. 107 and the wheel is built from this layout by removing jacks where the squares are filled. Because the pattern width, 40, is a factor of the total needles, the result is a vertical stripe effect. The addition of two needles to the machine causes the remainder to become 42 which is not a factor of the total needles nor the pattern wheel. The effect then becomes a spiral as indicated in the fabric illustrated at Fig. 108.

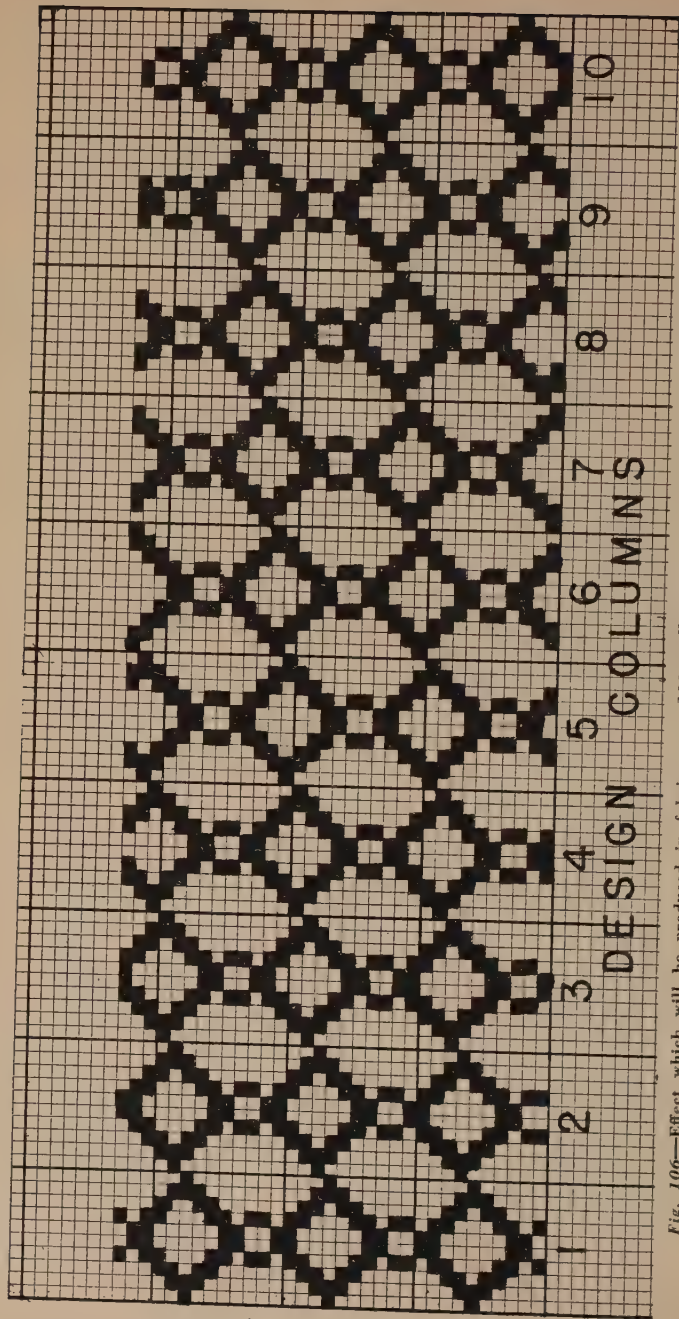


Fig. 106—Effect which will be produced in fabric on a 100-needle machine with a 110-cut design wheel built from Fig. 105.

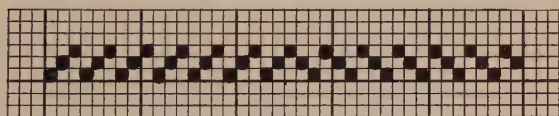
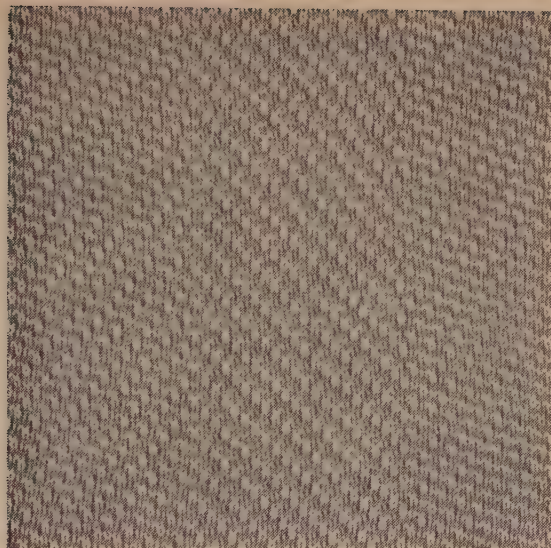


Fig. 107—Herringbone pattern from an 880-needle machine with one plain feed and one 120-cut jack presser.

The Float Stitch

The float stitch is common in flat-knit fabrics, but is not so extensively used as the tuck stitch. The principal reason for this is the fact that floating threads on the back of a fabric are easily caught. This is naturally undesirable in wearing apparel. A float across one or two wales is good practice in making vertical stripe effects on the finer gauges. Floats longer than this may be made, but the cloth tends to become loose and sleazy. On machines employing burrs for the stitch action, a blocked stitch wheel in combination with a cut presser, gives a float stitch. A block in the sinker burr places the yarn in front of the needle beard instead of under it. A deep cut in the presser acting on the same needle prevents the old stitch from being cast off.

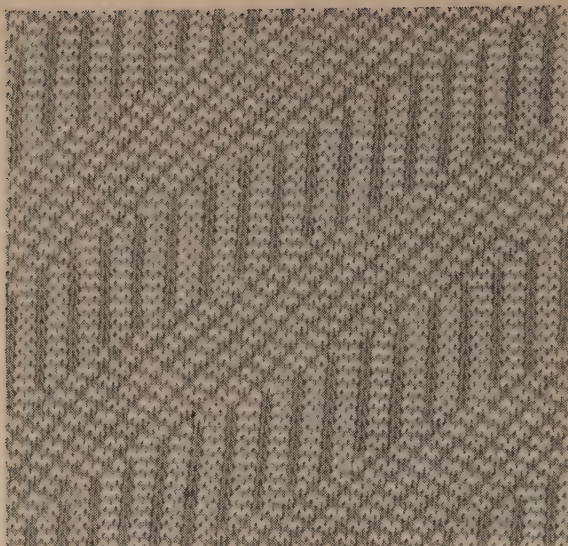


Fig. 108—Increasing the needles to 882 caused the pattern to change as shown above.



Fig. 109—Showing 1-and-1 tuck stitch on alternate wales and alternate courses.

A cam-and-jack or cam-and-needle action is used to produce the same result on other types of machines. In fine cloths, such as fine-gauged underwear, float stitches are sometimes mistaken for tuck stitches on casual examination. Close study with the aid of a magnifying glass, however,

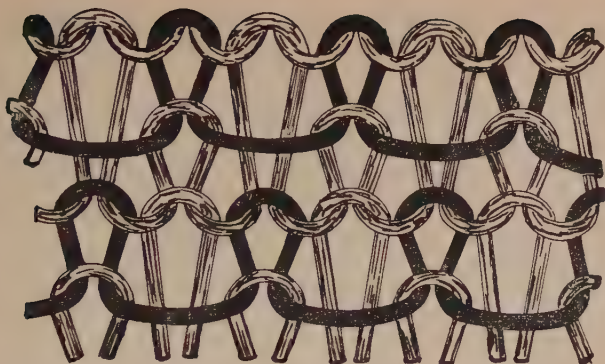


Fig. 110—Showing 1-and-1 float stitch on alternate wales and alternate courses.

will show the different stitch formation as seen by the sketches in Figs. 109 and 110. The float stitch has been used in the manufacture of fine underwear of the run-resisting type.

Reconstruction or Multiple-feed Fabrics

In the analysis of a knitted design, there are a few fundamental principles which should be adhered to. These principles involve a few simple calculations and are used in determining the factors which are essential for making the desired pattern. Information as to the number of needles, the gauge, and other manufacturing data can be arrived at with comparatively few complications.

Probably the simplest method of illustrating the principles involved is to take a sample swatch of cloth and, with no other information, find the data from which this cloth could be manufactured. For the present we shall confine ourselves to cloth knit on a single set of needles, and in which the pattern is formed by tuck stitches. The sample taken for this illustration is shown in Fig. 111.

The first step in analyzing the sample is to determine as nearly as possible the gauge of the machine on which the fabric was made or the gauge of the cloth. On plain work a method which gives fairly accurate results is to count the



Fig. 111—Spiral tuck stitch pattern with three pattern divisions.

wales in one inch of the cloth as it lies in its natural state without stretching. On pattern work the cloth is more open and wider than plain cloth of the same gauge. It is advisable therefore to take the next finer gauge than the count actually shows. On this particular sample, 11 wales were counted in one inch. Therefore, it is safe to assume that the cloth is 12 gauge. The sample is of average stitch length and texture. The next step is to ravel enough of the sample to determine the position of knitted and tucked stitches which make up the design. As the raveling of the sample

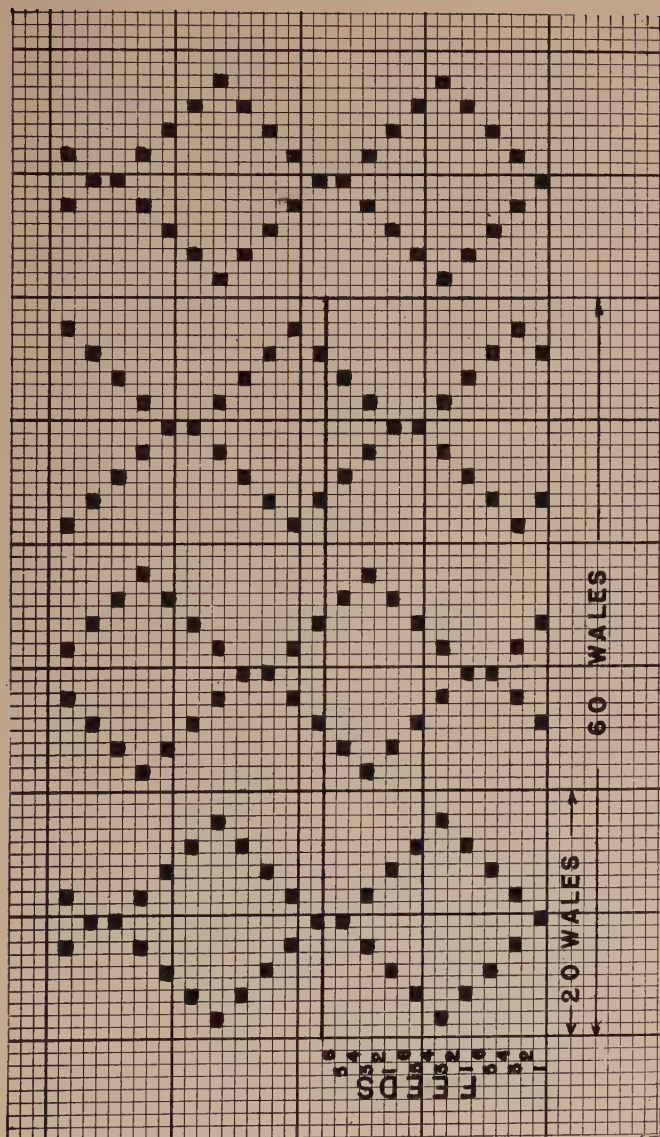


Fig. 112—Pattern layout for Fig. 111.

takes place, each knitted or tucked stitch should be marked in its respective position on cross-section paper. The result of this is shown in Fig. 112.

The shaded squares represent tucked stitches, while the plain squares represent knitted stitches. Before starting to ravel, one wale should be selected as a starting point and that particular wale maintained throughout the raveling operation. Probably the safest and most accurate raveling will be accomplished by concentrating on each individual stitch, indicating each stitch out as it is raveled, and forgetting how the finished pattern appears to the eye. The starting wale may be marked in any convenient manner such as inking, stitching-in a thread, or inserting a pin or needle. When the sample is of sufficient size, one repeat of both the height and width should be raveled in order that possible mistakes may be corrected.

When the pattern has been laid out on design paper, the next step is to determine the width and height of the design. It is seen from the layout that the design does not repeat itself stitch for stitch in width until the 61st wale. Therefore, the total width of the design is 60. Likewise, the height is not repeated until the 19th course. The height is therefore 18.

It may also be observed that there are three similar pattern divisions of 20 wales each in the design, each division rising upward and to the right six courses. This indicates that six feeds were used in producing the fabric, providing a lap of one division was used. Two other conditions are known which aid in determining the number of feeds: (1) There must be an even number of feeds, since each alternate course is plain knitting, and (2) the number of feeds must divide evenly into 18, since 18 is the height of the design. Six and two are the only numbers which meet these conditions. Two can be eliminated because of the fact that the rise is six courses. This leaves six as the only remaining number. It follows therefore that six feeds were used for this pattern.

Another important item remains to be determined, the

number of needles required in the cylinder. Before the question of total needles is taken up, let us summarize the result established:

Gauge: 12.

Design Width: 60 wales.

Width of one division: 20 wales.

Number of divisions: 3.

Total height: 18.

Rise: 6 courses (upward to the right).

Number of feeds: 6 (3 knit feeds and 3 tuck feeds).

Concerning the needle calculations, it has been observed that there is a lap of one division. Therefore the number of needles in the cylinder must be divisible by 60 with a remainder of 20 (one division). As the design rises upward and to the right on the face, the remainder should be a plus 20, thus giving the presser a chance to gain 20 needles on the cylinder at each revolution. It should be kept in mind that the back of the cloth is on the outside while it is being knitted and the diagonal of the pattern appears upward to the left on the back. The number of needles of course depends upon the size of cylinder to be used; but whatever the cylinder, the number of needles contained in it must be divisible by 60 with a remainder of 20. Suppose, for example, the theoretically correct number of needles in a 20-inch cylinder on 12-gauge were 502.

Then, $502 \div 60 = 8$, with a remainder of 22.

The remainder must be 20, but it is possible to change a few leads in actual practice. A reduction to 500 would be permissible and would give the desired remainder. Therefore, $500 \div 60 = 8 + 20$ remainder which satisfies all the conditions necessary for reproducing the pattern.

Chapter IX. Interlock Knitting

INTERLOCK fabric is a knitted fabric normally constructed from cotton yarns of good quality. It is formed essentially of two rib fabrics so interlocked together that the wales of one fabric lie between those of the other on both the face and back. The result is a cloth alike on both sides. It presents surfaces much smoother than rib cloths, and similarly to rib cloths, it may be stretched to a considerable extent in width. Like the rib fabric, it has no tendency to curl and this quality combined with the absence of skew from yarn twist, so characteristic of other knitted fabrics, makes interlock a desirable fabric to cut and sew. The peculiar structure also gives body and great durability to garments made from it. This is especially true where soft-spun combed yarns are used.

The knitting of interlock fabric originated in America but was to become widely used first in Europe. It later was adopted in America, and especially since World War II, has seen considerable growth in popularity for use in men's and boys' T-shirts, children's clothing, and in pajamas for both men and women.

The fabric requires a special machine for its production. The interlock machine is similar in appearance to a rib machine in that it has both a cylinder and a dial. The cut of these is relatively fine and both cylinder and dial are fitted with a long and short series of needles arranged alternately (one long, one short) in both cylinder and dial. The long and short needles have independent cam races. This makes it possible to control the needles independently. This provision makes it possible for all odd needles, both cylinder and dial, to rise and knit at all odd feeds (1, 3, 5, 7) while the even needles, cylinder and dial, rise to knit at the even feeds (2, 4, 6, 8). In this order of knitting half the needles are idle in a holding position at all feeds. In other words, some sacrifice in the knitting capacity of a machine is made to produce the interlock stitch. This sacrifice, how-

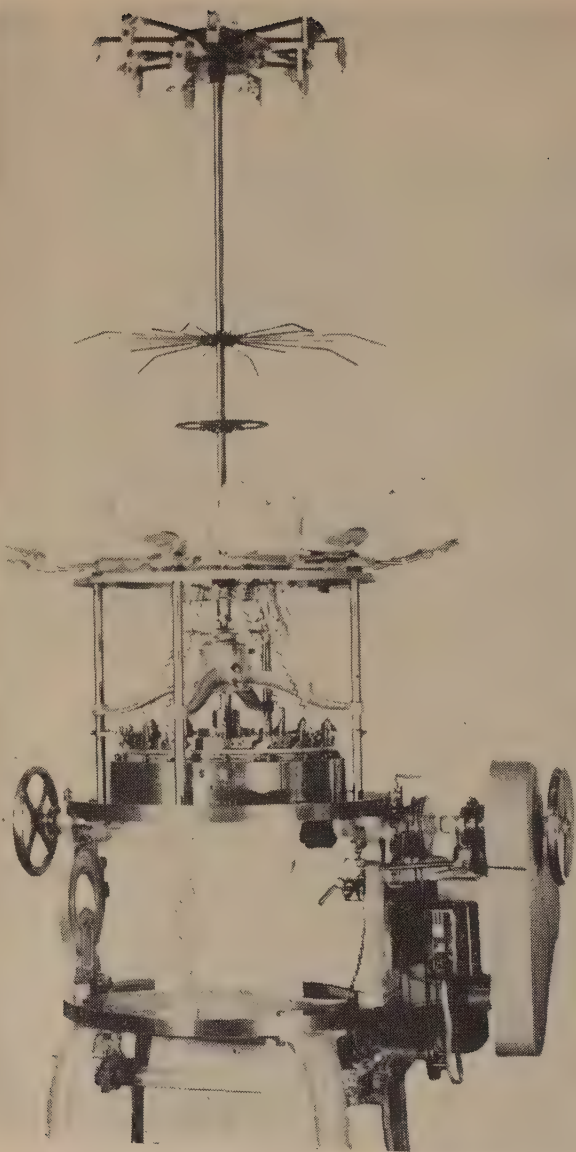


Fig. 113—Scott & Williams interlock machine.

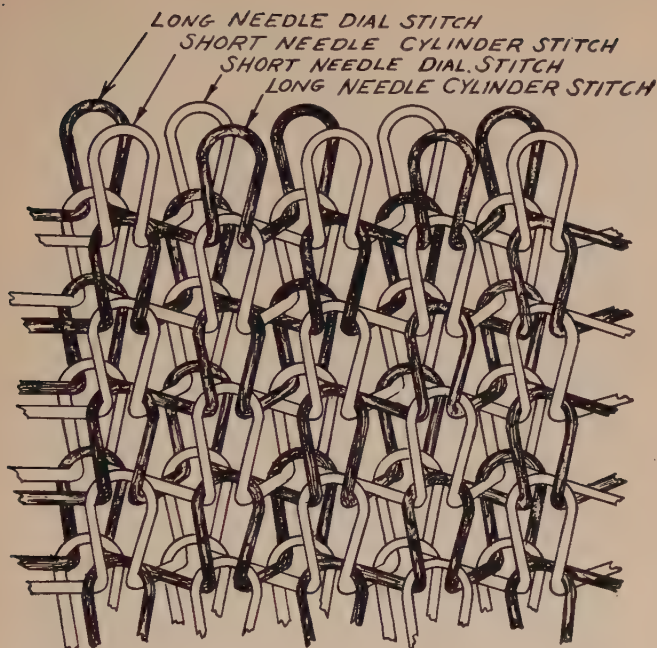


Fig. 114—Diagram showing formation of the interlock stitch.—*Courtesy Scott & Williams, Inc.*

ever, is counterbalanced by the superior qualities of the fabric produced. A machine produced by Scott & Williams for interlock is illustrated at Fig. 113. This machine has a stationary cylinder and a revolving cam ring.

The interlock stitch is illustrated at Fig. 114. The alternate courses are shaded black to aid in tracing the passage of the course from front to back or from cylinder to dial needle. Samples of interlock cloth are shown at Fig. 115. Regular interlock is illustrated at top left. A vertical hair-line or wale-and-wale effect is shown at top right. This pattern is made by threading the feeds alternately white and blue. Threading the feeds two white-two blue produced the horizontal stripe at center left. Four-and-four threading produced the effect shown at lower right. Color effects shown at center right and lower left illustrate irregular orders of threading.

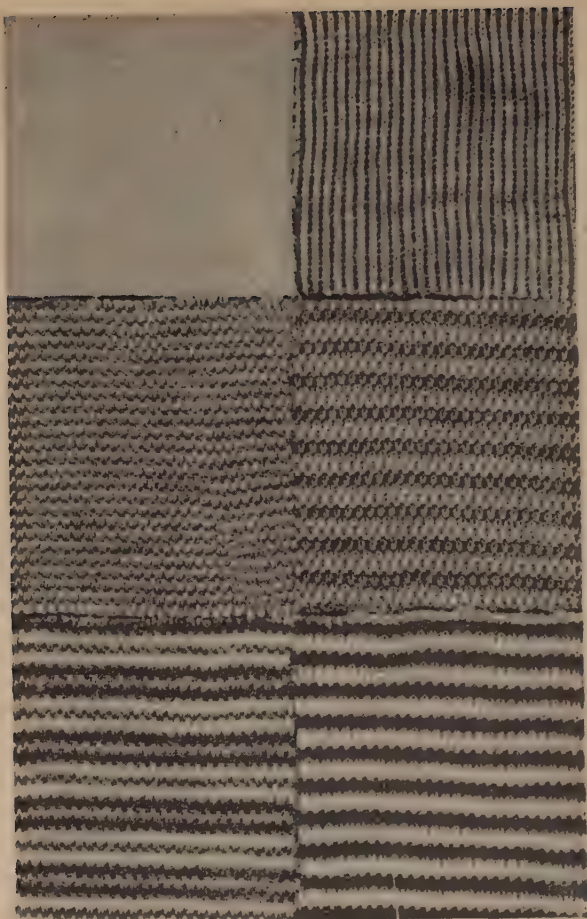


Fig. 115—Samples of interlock fabric illustrating the effect produced by various orders of threading the machine.

Cylinder and Dial Cam Sections

The cylinder and dial cam sections are shown at Fig. 116. The top view shows two sections from the dial cap. The left one of these (No. 1) actuates the long dial needles in the knitting feed. The clearing cam *a* extends them to take on yarn. The stitch or knock over cam *b* withdraws them

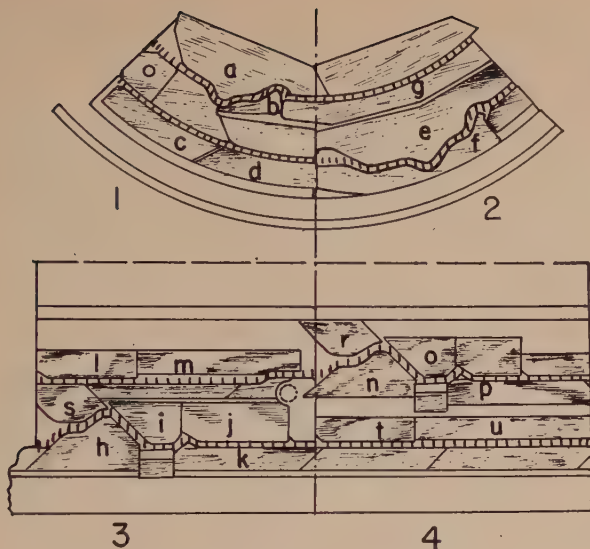


Fig. 116—Diagram showing the dial and cylinder cams: 1 and 3 are long-needle sections; 2 and 4 are short-needle sections.

to their full inward position where they cast off the stitch. It will be observed that the outer or short needle raceway follows the arc of a circle which means that these needles will pass in the idle or non-knitting position. The cam section at the upper right (No. 2) has a clearing cam *e* and stitch cam *f* in the short needle butt raceway which operate this series of needles to the knitting position at this feed. The butts of the long needles follow in the arc of a circle behind the cam *g* and do not knit. Cam sections, one for each feed, are arranged alternately around the dial cap.

The cylinder cam sections are shown in development in the lower half of Fig. 116. The long needles are raised to clear by *b* and descend to knit on the stitch cam *i*; *j* is a guard cam. Cam *k* in this section gives a slight rise to the needles on a point provided at the extreme left. This rise coincides with the point at which the corresponding dial stitch is being drawn and serves to relieve the yarn of too much stress at this point. Holes in the fabric are reduced

because of this feature. The short cylinder needles follow a straight line under cams *l* and *m* and do not rise to knit at this feed. The right section is from a short-needle knitting feed. The short needles ride up on cam *n* to clear and are drawn down to the knitting position on the stitch cam *o*. Cam *p* is shaped the same as *k* and provides a slight rise to relieve tension on the cylinder stitch while the dial stitch is being formed. The long-needle butts follow a straight path under cams *t* and *u*.

Formation of the Interlock Stitch

Interlock fabric is knit on a machine having both a cylinder and a dial. It produces a fabric knit alternately on two sets of needles. The cylinder carries two lengths of needles, spaced alternately, and operated by two cam races in the cylinder cam ring. The dial also carries two lengths of needles, spaced alternately, and operated by two cam races in the dial cap.

The needle cam races, for both the cylinder and the dial, are so constructed as to operate on the long needles in passing through every other feed, and to operate on the short needles in passing through the alternate feeds. This allows the long cylinder needles and the long dial needles to operate on every other feed and the short cylinder needles and the short dial needles to operate together on alternate feeds. The short needles in the cylinder and dial are held out of action while the long needles are operating, and the long needles are held out of action while the short needles are operating.

Setting Up and Adjusting the Interlock

The machine should be uncanted carefully, as rough treatment is likely to throw out some of the adjustments. The dial and cylinder are set to operate with .002 inch maximum runout. The machine should be thoroughly cleaned of all grease and other foreign particles, particularly machined

pads or parts which are joined together. The presence of dirt between them will cause misalignment.

Before bolting on the bracket it should be cleaned thoroughly. The clutch mechanism should be free of excelsior or paper packing. Next, place the drive bracket onto the frame of the machine. The drive pinion gear must be held inside the frame and the drive shaft put through the gear. The pinion gear cannot be placed into position first because of the bevel on the pinion and ring gears. Tighten the pinion gear onto the drive shaft by a $\frac{5}{16}$ -32 Allen set screw wrench and lock the key by a 10-32 Allen set screw wrench. Caution must be exercised not to set the pinion so that it binds with the ring gear. About $\frac{3}{8}$ ths of an inch backlash at rim of hand wheel should be allowed. Do not try to turn the machine by hand at this time, as the gear ring is clamped in place by a temporary button to prevent movement while in transit.

Motor Mount—Place the motor mount bracket on to the machine. This is fastened to the center plate with two bolts and to the frame with one bolt. Fasten the motor brackets on the mount and secure inside bracket to mount with a bolt and nut. The hold-down lug has an elongated slot for adjustment. The idler pulley, shaft, and arm are located on the shaft which holds the motor brackets. The motor is fastened to the brackets with four bolts and the nuts but do not tighten it.

Two small V-belts run from the motor pulley to the idler pulley and two large V-belts from the idler pulley to the drive pulley. With the belts in position, pull the motor backwards to tighten the belts and secure the motor in position. If the large V-belts are still slack they may be tightened by a screw and nut adjustment located in a lug on the underside of the idler pulley arm.

The switch box is attached to the drive bracket. A drilled hole is provided for this under the clutch handle control. The belt guard is attached to the drive bracket with two screws and to a lug on the outside motor bracket with one screw. The hand wheel must be removed to put on the guard.

The Stop Motion—Remove the nuts which hold down the cross-bar, put on the pillars, and turn down tight. The stop motion should be removed from the packing case with care to avoid bending or breaking any of the small parts. The stop motion collector ring is placed onto the pillars which is followed by the bobbin stand and nuts to hold it down. Assemble the stop motion carefully, install it on the machine, and wire according to instructions furnished by the stop motion manufacturer.

Turn the nuts to the end of the rod which is attached to the take-up and passes through the bed plate. Adjust the knock-off chain so that when the knock-off lever is in running position and the take-up is at its lowest operating position, the length of the chain will be such that a further downward movement of the take-up, due to a press-off, will tighten the chain and operate the knock-off to stop the machine.

A shaft with a bevel gear attached is placed into the long hub on the take-up so that the gear will mesh freely with the bevel gear already on the take-up. A grooved pulley is placed on the other end of the shaft, and after tightening the set screw check to see if the mechanism turns freely. A round belt runs from the grooved pulley on the take-up to the grooved pulley on the right-hand drive bracket. Hook the counter weight hanger over the take-up frame and use as many counter weights as necessary to keep a slight tension on the fabric. Adding weights reduces while removing weights increases the tension on the fabric.

To Start the Machine—Remove the lock buttons on the cam ring and replace them with the regular buttons. These parts are marked with a tag. Care should be taken that they are put on correctly so they do not interfere with the movement of the pillars. Check the entire machine carefully, then put on the yarn and check the stop motion. To remove dial or cylinder needles study the drawings. Turn the machine slowly by hand, making certain that none of the yarn guides are making contact with the needles, as they might have been moved during transit.

Yarn Carrier Setting—The carriers should be set so that the trailing edge is approximately $\frac{1}{64}$ th of an inch from the cylinder needles and one needle from the point of latch closing. The front of the carrier should be approximately $\frac{1}{16}$ th of an inch from the cylinder needles and the bottom of the carrier should be approximately $\frac{1}{32}$ nd of an inch above the dial needles.

Needle Protector Setting—Adjust the needle protector points at the lowest possible position to clear the needles so that, should a needle break or a heavy slub enter the needles, it will contact the protector point, tripping it and stopping the machine.

Truing the Cylinder—Place the cylinder in the bed plate with stampings to the front of the machine and tighten the screws lightly. Turn the machine by hand which will carry the indicator around the cylinder, since it is attached to a pillar as shown in the drawing. The indicator button bearing against the cylinder will indicate in thousandths of an inch any eccentricity. Tap the cylinder on the inside with a lead hammer or the equivalent.

Tighten the screws holding the cylinder to the bed plate in this position and then recheck with the indicator to make sure the cylinder has not moved due to tightening the screws. The holes in the bed plate are oversized to permit this slight amount of adjustment.

Cap and Dial Assembly—Place the dial with the hub attached on the cylinder so that the hole for the indicator rod in the underside of the dial and the stampings are to the front of the machine.

Lay the cap on the dial. Place the cross-bar on the pillars so that the No. 1 stamped on the end of one arm is on pillar No. 1. Insert spindle, place on ball bearing, spacer, and drip cup. Tighten the drip cup screw first and then the set screw. Put on the spindle wheel and raise the dial up to desired height and lock in position with two set screws in the hub on the cross bar.

Aligning the Dial—A threaded hole is provided in the underside of the dial to receive a rod. A bent rod is at-

tached to the first rod by means of a clamp. The indicator is clamped to the bent rod with the button resting on top of the bed plate, which checks the movement up and down the dial. The dotted line position of the indicator with the button resting on the side of the bed plate checks the movement back and forth of the dial.

When a machine is taken down, the dial should be checked, and trued if necessary before the needles are replaced in the machine. Machines with fabric on them may be checked by slitting the fabric directly below the threaded hole in the dial which holds the indicator attachment. Care must be exercised that the fabric does not bear on the rods holding the indicator while readings are being taken. The eight chucking screws which adjust the dial spindle bushing are used to correct the dial movement, and when thoroughly adjusted the indicator should not show more than three-thousandths of an inch movement of the dial. The actual movement of the dial will be less than three-thousandths of an inch as the length of rod multiplies the movement to the indicator.

Setting the Dogs—Put in the dial needles and loosen all of the dogs. Set the adjusting screw on one dog approximately midway between the point of no tension and heavy tension on the spring. Check the mesh with a cylinder needle to the dial needles and then bring the remaining dogs into like contact. Final adjustment will be made after the fabric is on the machine.

Setting the Side Cams—Adjust the side cam .008 to .010 of an inch from the dial needles. This may be accomplished by placing the paper folded to that thickness on top of the dial needles and under each end of the side cam. Press the cam down onto the two pieces of paper and tighten the holding screws, then remove the paper.

Setting the Presser Cams—Put in the cylinder needles and set the presser cams .008 to .010 of an inch from the cylinder needles. This may be accomplished by placing paper folded to that thickness against the cylinder needles.

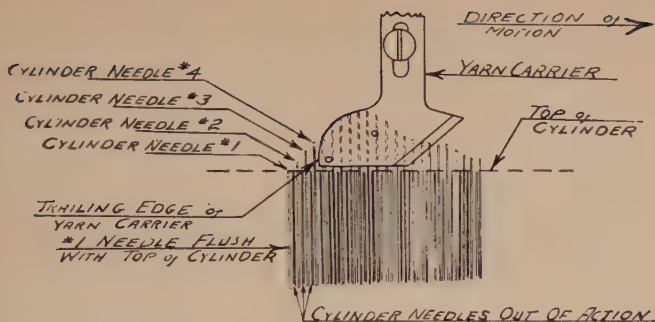


Fig. 117—Diagram showing position of the yarn carrier relative to the active needles.

Press the cam in against the two pieces of paper, tighten the holding screw and remove the paper.

Cylinder Stitch Cam Setting—With the fabric off of the machine, set the stitch cam so that the tops of the needles will be approximately $\frac{1}{32}$ nd of an inch below the top edge of the cylinder.

Cap Setting—Set the cap so that the dial needle just going in over the edge of the dial is to the right of the cylinder needle which is being raised flush with the top edge of the cylinder. Shifting of the cap slightly either way may be necessary after the machine has started to knit.

Preliminary Yarn Carrier Setting—When setting the yarn carriers without fabric on the machine, start with the cylinder needle which is flush with the top of the cylinder and

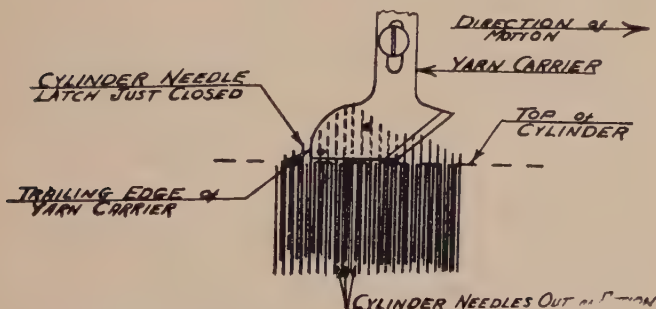


Fig. 118—Final yarn carrier position with fabric on the machine.

count four needles in the direction of the motion of the cam ring and place the carrier so that its trailing edge is over the next dial needle.

Pressing-on the Fabric—Use a lightweight fabric, preferably 1 x 1 rib, pulling the non-ravel end up between the cylinder and the dial and barely hooking it onto the needles directly over the dogs. Then hook on the remaining fabric. See that the latches of both the cylinder and the dial needles are open. A small toothbrush may be used for this purpose. Check the fabric to make sure that all the dogs are doing the same amount of work. If one or two of them are taking most of the load, back off on them until they are all even. At the same time check the mesh of the needles. Recheck the yarn carriers so that they will be one needle from latch closing as described.

Dial Knock-over Cam Setting—Set all of the dial knock-over cams (stitch cams) the same, they should just clear the stitch, cutting may take place if they are set too deep and tucking if they are not deep enough to clear the stitch from the needle.

Dividing Cams—The dial dividing cams should not require any change as they have been set at the plant. In case the fixer feels these cams should be adjusted, special instructions should be obtained from the manufacturer. The screws used for this adjustment are shown on the cap drawing and should not be confused with the knock-over cam screws.

To Obtain a Uniform Stitch—To even up the stitch, bring the pillar number one to the front of the machine (this should be done each time the yarns are marked). Mark each yarn at the lower yarn guide ring, bring the markings down to a point on the yarn carriers and adjust the cylinder stitch cam accordingly.

Stitch Control by the Dial—Raising or lowering the dial will alter the length of the stitch. A high dial will give a loose stitch and a low dial, a tight stitch. Usually the dial is set to a height above the cylinder so that a cylinder needle

of the same gauge used in the machine will make approximately three quarters of a turn when inserted between the dial and cylinder. In lowering the dial, always go beyond the point desired and then bring the dial up to that point. This takes the backlash out of the thread on the center spindle.

Recover all broken butts from the cam raceways after a smash. This includes both the cam ring and the dial caps. Keep the side and presser cams in proper adjustment. This should always be checked after a smash. Oil the needles two or three times during an eight-hour period. Check the take-up once every eight hours to see that it is running freely and has the proper weights on it for the fabric being made. A poorly running take-up may cause a load-up on the needles.

Set the yarn carriers properly. If they are not set correctly, the latches may be bent. Make a careful selection of yarns so that the gauge is not overloaded. If yarns are too heavy, needle damage may result. Blow off the machine every ten to 15 minutes while they are running or every 30 to 45 minutes with the machine stopped. Care and judgment must be exercised with either method or lint may be blown into the needles to cause damage. Use good yarns. This will reduce the number of holes which are much more frequent than needle damage. Fixing should be done carefully, keeping all screws tight. Check the stop motions once every eight hours.

Lubricating the Machine—For flushing out and lubricating the needles it is best to use a stainless needle oil which may be secured from most of the oil companies. For lubricating the machine a good grade of No. 20 oil should be used. The machine should be oiled once in eight hours. The machine should be greased through the fittings once a week.

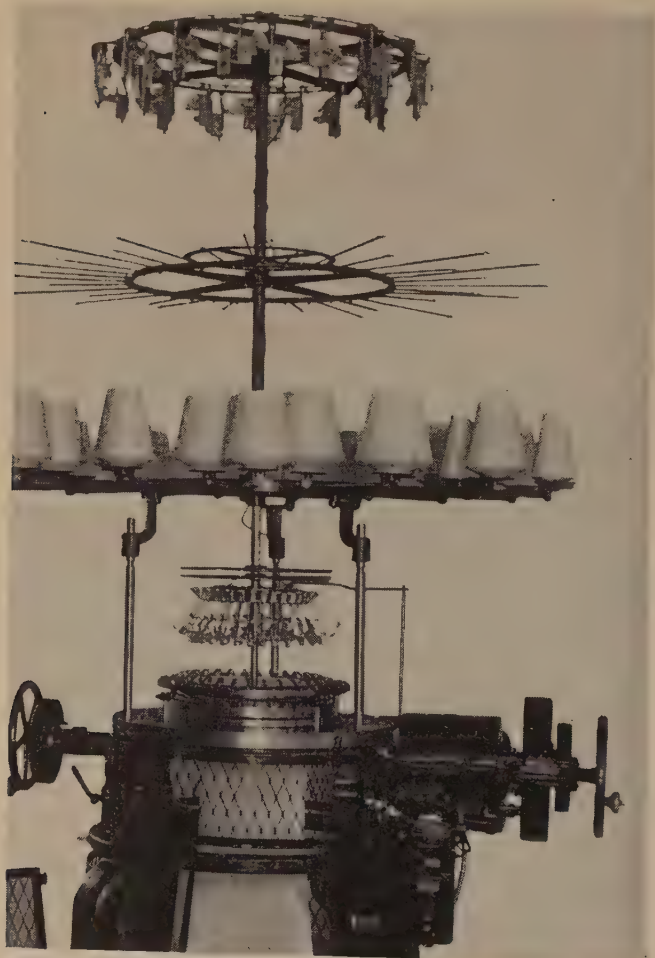
Chapter X. Fabric Production With Latch Needle Pattern Wheel Machines

THE productive capacity of machines for jersey cloth production has been greatly accelerated by the development of machines of the sinker-top type in which the feeds are arranged at close intervals around the cylinder so that the needles are caused to rise and fall in a continuous wave, thus producing many courses of knitting in a single revolution of the machine. Machines containing a cylinder 24 inches in diameter have been built with as many as 64 feeds, and a little calculation will show that each feed occupies approximately $1\frac{1}{4}$ inches in this machine. The Brinton RMP machine is a fabric machine of this class and when operated at 25 revolutions per minute is capable of producing fabric at the rate of 80 linear yards per hour with 32 courses per inch. This accomplishment has been made possible by use of a relatively short latch needle and a well designed cam section which actuates the needles in such a manner as to attain maximum efficiency.

The use of a needle fitted with a short latch reduced the rise of the needle necessary to clear the stitch, thus tending to level out the knitting wave, and permitting it to be shortened in length proportionately. Fig. 119 is a close-up view of the head of the RMP machine showing the yarn guides, sinkers, and cam ring with one section removed to expose the needle butts and raising cams. By observing the position of the needle butts it will be seen that approximately six needles only are at the clearing position at each feed. The others are either descending to a stitch-drawing position or are rising to clear. It may also be observed that the line of descending needle butts is a curve and not a straight line. This curve conforms to the left face of the stitch cams shown in the cam section—which has been removed. This feature results in a uniform acceleration in the rate of descent as the needle approaches the stitch-

drawing position and serves to reduce strain on the yarn. Fabric knitted from a given yarn with cams shaped in this manner will not have as many holes because of this reduction of strain on the yarn.

Another feature built into the Brinton machine which contributes to greater ease in stitch formation is the so-



The Brinton Model RMP machine.

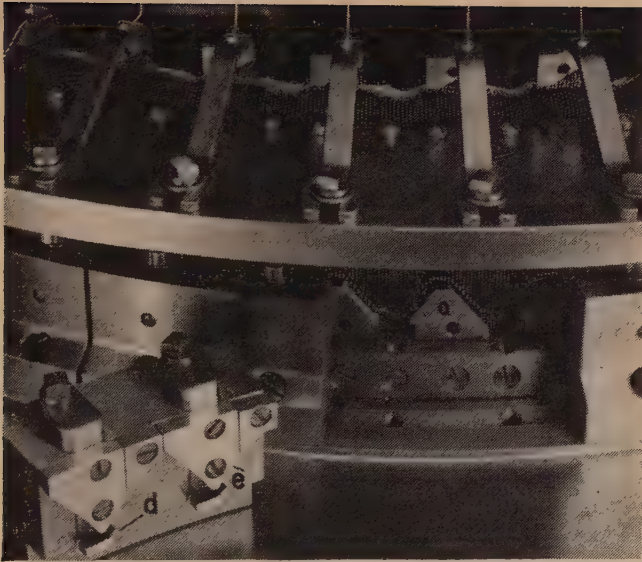


Fig. 119—View of knitting cams of Brinton RMP machine, with section of cam block removed to expose cushion-type cams.

called "cushion" cam shown at *d*, Fig. 119. This cam is, in short, a small raising cam located just under the point of the stitch cam with sufficient clearance to permit free passage of the needle butts. Its shape assures that the needle will be raised slightly immediately after the stitch is drawn. The slight rise given to the needles relieves strain on the stitch as soon as possible. Since the cushion cam is attached to the stitch cam adjusting stem, any change made to shorten or lengthen the stitch does not alter the spacing between the stitch cam and its cushion cam. By studying the needle butt wave in Fig. 119 it will be seen that a minimum of two or three needles are down at the knitting point.

The RMP machine is used in the production of plain jersey cloth which may be bleached for garments for both outerwear and underwear. The machine has also found wide use in knitting ingrain work for boys' clothing, particularly polo shirts. The great number of feeds make it adaptable to the production of various stripe effects by threading the

machine with several colors of yarn arranged according to some plan. Fabric containing 32 courses per inch may thus be knitted with a horizontal striped pattern extending two inches in depth where a 64-feed machine is provided. It should be pointed out that patterns may be changed on this machine by simply rearranging the cones for yarns of a different color. All yarns feed continuously and no striping devices are contained on the machine.

Problems in Fabric Finishing and Utilization

Circular knit goods in tubular form are not finished on a tenter frame. The machine used is the finishing calender which resembles an examining machine on which the goods are rolled up after they are steamed. Fixing the width of the cloth is done by means of a spreader which is a horizontal one-plane piece of light pipe shaped like an isosceles trapezoid. The tubular goods pass over the spreader, are steamed and then rolled on a paper tube. The spreader is placed against two larger, closely spaced, and parallel guard pipes which permit the goods to pass through but hold back the spreader in its position. The flow of the goods keeps the spreader in place against the guard pipes. The width of the spreader determines the width of the cloth; the steaming process plus finishing chemicals with which the goods were previously treated set the cloth to calculated width. Spreaders are either fixed in width or adjustable, are made of polished brass or stainless steel, are relatively light in weight, and about two feet in length.

As the elasticity of the knit fabric makes it cling to the edges of the spreader, there is a certain amount of friction present at the edges which is absent in the middle of the spreader. As the spreader is a horizontal affair, the presence of friction at the edges and lack of friction in the center of the cloth causes a perceptible bow which may equal three inches in a cloth 20 inches wide. The bow goes in toward the finishing roll as the center of the cloth tends to travel slightly faster than the edges.

If the circular knit goods are given a second run on the

finishing calender in a direction opposite to that of the initial run, the bow will be removed by the second compensatory run. However, even the two-run calendering of jersey does not make for a perfect horizontal stripe. The more perfect the horizontal polo shirt stripes are, the easier it is to cut and sew the shirt itself.

As the horizontal spreader causes bowing of the stripe in knit goods, the development of a non-horizontal method of finishing was naturally explored. A machine has been made to handle knit goods finishing by drawing the goods vertically over a long pipe, usually from one floor to the upper floor, with cloth being fed from the lower floor and rolled on a paper tube on the upper floor. This machine is not always a convenient installation, and processing on it is slow and not too accurate. On the horizontal-type calender, experiments have been made with a circular-mouth spreader; however, this method is not generally used, probably because of practical difficulties.

There are several types of knit goods finishing calenders, each with its particular advantages. One type carries the goods on a revolving blanket which in turn rolls them up on a paper tube. This is a high-speed machine. Another type calender has vertical rollers and rolls the cloth vertically. This machine is slow, but makes a neatly rolled package. Heated rollers are ideal for rayon and wool cloths. It is sometimes troublesome to thread cloth through vertical rollers, and one machine of this class is provided with a special threading device.

A new situation arose when the high-speed, 64-feed knitting machine came into the field. Due to the large number of yarns going into the circumference of the tubular cloth at each revolution, the yarn-dyed stripe does not knit in a horizontal position but appears as a spiral. As this is a cloth construction problem rather than a finishing problem it is usually solved by splitting the cloth on one side through its entire length and rematching the stripes so that they fall normally at right angles to the cloth's edge. The split side is sewed up so that the cloth becomes tubular again. Another method of handling the problem involves

splitting the goods and finishing flat on a pin-tenter frame. However, with this latter method, the cutter would have to learn a new system of cutting the goods and there would be no particular saving since the sides of the shirt would have to be sewed together to restore the tubular condition.

The frictional effect of the horizontal spreader has been overcome on a calender equipped with a set of rubber wheels fitted just outside the spreader traveling at the same speed as the calender. These wheels rotate and help to push the goods along by overcoming the friction at the spreader edges. However, while the edges of the cloth are straightened, there is still a bow in the center of some cloths which can be corrected only by two runs of the cloth through the calender.

This rubber wheel attachment has been improved by providing a variable speed drive for the rubber wheels. The operator can adjust this speed faster or slower as the goods require. A special type spreader provides space for the rubber wheels and facilitates the passage of the cloth by equalizing the friction of the cloth on the spreader. This system processes the stripes in true horizontal fashion and is currently the proper means of finishing polo shirt stripes. As this machine straightens the courses and wales of the knit fabric, it is ideal for proper finishing of cloth in solid colors as well as striped cloth.

Selective Striping

The principle of selective striping was adopted to extend the range of pattern work on sinker top jersey machines. It has previously been pointed out that in machines of the RMP class all yarns are fed continuously and that for a 64-feed machine the pattern must repeat on 64 courses or some factor of 64, assuming that all feeds are in use. Selective striping machines are equipped with striping devices which permit yarns to be thrown out of action to eliminate a particular color from the fabric for a certain number of courses, thus adding variety to the fabric which cannot be obtained with continuous feeding.

The Brinton automatic selective striping machine illus-

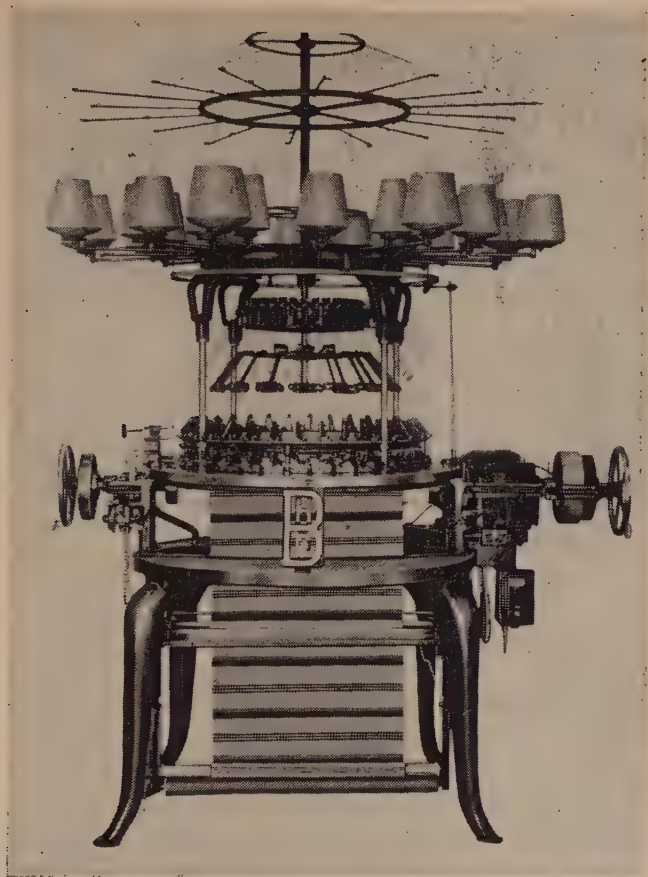


Fig. 120—Brinton selective striping machine.

trated at Fig. 120 is a machine of this class. Its principal features include an extremely long take-up wire at each feed designed to maintain tension on the yarn when it is thrown out of action. A close-up view of the knitting head of this machine is given at Fig. 121 showing how the yarns are striped in and out. Each feed is equipped with a striper and tuck bar. The striper finger is thrown out of action when the cam shaped end of the lever is struck by the operating plungers 1, Fig. 120. Instead of cutting and



Fig. 121—View looking into Brinton 24-inch, 32-feed automatic selective striping machine, Style S.S. Note control of yarns to eliminate floating yarn waste.

clamping the yarn as it comes out of action, it remains attached to the fabric and rotates with it until put into action again. The machine shown at Fig. 121 is knitting color with all white yarns out of action. The idle yarns in rotation are twisted into a compact roll under control of a special yarn guide, which eliminates floating yarn waste.

Yarn Finger and Tuck Bar

The yarn finger which controls the feeding of yarn is shown at *A*, Fig. 122. The end of this finger when lowered to knitting position rests in a notch *B* cut into the latch shield and is actuated by the lever *C*. To remove the yarn from the knitting at a given feed requires a change in the position of the knitting cams to prevent pressing off the work. This is achieved in the selective striping machine by providing a tuck bar *C*, Fig. 123—whereby a sliding section of the clearing cam—Fig. 123—is lowered automatically to tuck or non-knitting position. The tuck bar goes into action immediately before the yarn finger is raised and is not raised until the yarn finger returns the yarn to the

needles. The same motion which lowers the clearing cam segment also permits the corresponding stitch cam to rise slightly to relieve the yarn of undue strain at the idle feeds. This motion is given through the lever *E*, Fig. 123. This lever has the stitch adjusting screw *D* at its outer end and



Fig. 122—View of yarn finger and yarn finger lever from S.S.W. machine.

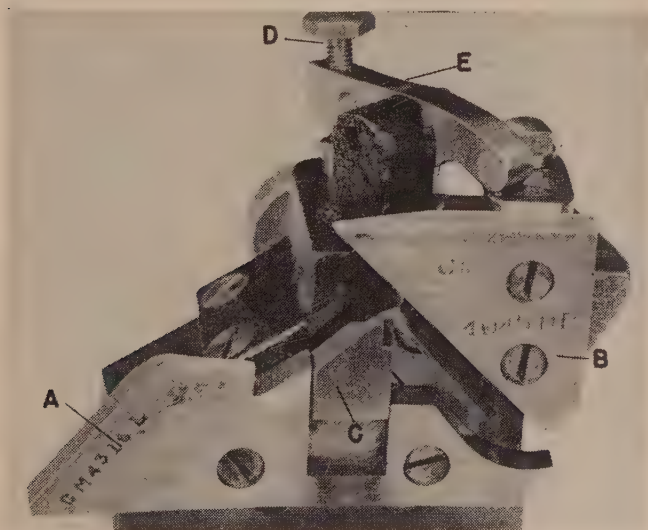


Fig. 123—Inside view of cam ring section from a 24-inch, 32-feed S.S.W. Brinton machine.

depresses the stitch cam *B* to full knitting position when the tuck bar is in the knitting position. When the tuck bar is moved to tuck position, pressure on the stitch cam post is released, permitting it to rise slightly under control of a coil spring located in the cam block. Fig. 124 shows the outer view of the cam section with tuck bar operating cam *F*. Both the stripers and tuck bars are controlled by pattern chains located at the side of the machine, Fig. 120.

This machine is built so that feeds in groups of two but individual yarns may be thrown into or out of action by arranging different colored yarns on different feeds. These feeds can be put into action at will, in groups of two or more, and thus make stripes in any width, spacing, or combination desired.

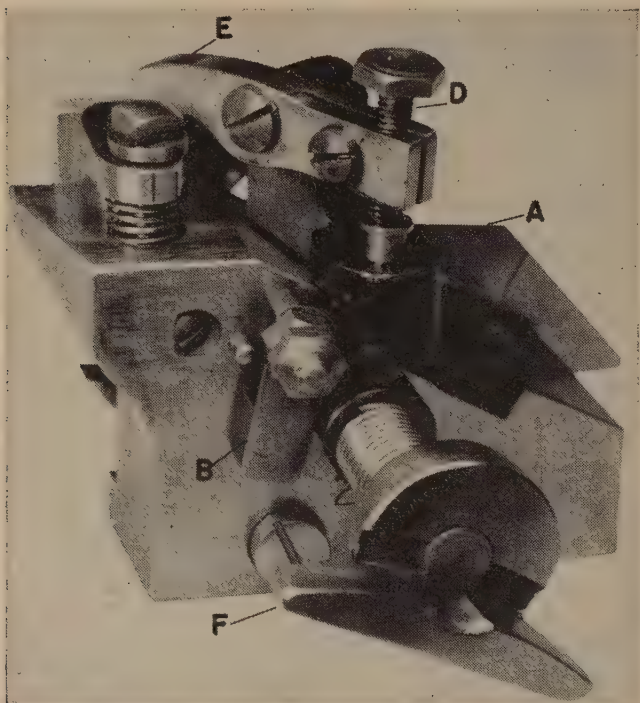


Fig. 124—Outside view of cam ring section from 24-inch, 32-feed Brinton S.S.W. machine.

The mechanism for throwing the feeds into and out of action is controlled by a chain at the side of the machine. This chain is moved by cams mounted on the gear ring of the machine, and these cams are placed at points on the machine where a change of feeds is to occur.

A high link on the chain operates the upper and lower plungers on the stand at the side of the machine, and the upper plungers will throw into action any feeds which they engage. The low links also operate the upper and lower plungers, and these will throw out of action any feeds which they engage. Therefore, by arranging the high and low links in the machine and the proper cams on the gear ring, any arrangement of feeds in action or out of action can be obtained. Probably the best method of explaining the operation of the machine will be to make up a pattern and explain the various steps in its production. Assume for example that a fabric is to be knitted as follows: 48 courses of blue, six courses of red, eight courses of blue, four courses of white, eight courses of blue, six courses of red, and then repeat. To set up this pattern, the yarn feeds would be arranged on the machine as follows:

1— 6 Red
7—14 Blue
15—18 White
19—26 Blue
27—32 Red

The cams on the gear ring operate behind the stand at the side of the machine which makes the change, so that these cams are placed slightly behind the feeds which they operate. In this case, the cams would be placed at the following positions:

Between	2	and	3
	8	"	9
	16	"	17
	20	"	21
	28	"	29

The chain would be made up as follows:

4 High Links

1 Low "

2 High "

1 Low "

2 High "

1 Low "

1 High "

1 Low "

2 High "

There are two types of high links. One is a full link and the other is beveled off in front. The beveled link must be used at the beginning and if followed by additional high links, full links will be used. The chain should be placed on the machine so that the first high link operates the upper plungers in time to act on feed No. 1. As there are five cams on the gear ring, the chain will be moved five times in one revolution, and as this chain starts with five high links, all feeds will be thrown into action on the first revolution of the machine.

The sixth link, which starts on the second revolution, will be a low link, and this will throw out of action the six red feeds. The next link will be a high link, which will keep in action the eight blue feeds. The next link is a low link, which will throw out of action the four white feeds. The next link is a high link, which keeps in action the eight blue yarns. The next link is a low link, which throws out of action the red yarn, and the next two rounds of the machine are the same as the second round, starting with a low link and ending with a low link. This completes the entire pattern in four revolutions of the machine.

Many different combinations of stripes can be obtained by using different combinations of the cams, links and yarn on the machine. However, the objective is to knit on as many feeds in one revolution as is possible in order to get the greatest production from the machine. The operator will soon determine the best method of doing this after setting up a few patterns. Assume for example that a pat-

tern is to be knitted as follows: 64 courses of blue, six courses of red, four courses of white, six courses of red, repeating with 64 courses of blue, etc. Feeds would be set up as follows:

1—16 Blue
17—22 Red
23—26 White
27—32 Red

The cams would be placed on the gear ring bed between feeds 2 and 3; and 18 and 19. The chain would be built as follows:

1 High
1 Low
1 High
1 Low
1 High
1 Low
2 High

This makes eight links for four revolutions of the machine, which completes the pattern. However, since the chain would be too short with only eight links, it would be necessary to duplicate the combination of links until the chain is sufficiently long to go on the machine. In other words, it would probably be necessary to have this pattern set up four times on the chain making 32 links.

When making body stripes, or where there is a large portion of one color with a small portion of stripes, it is sometimes desirable, in order to eliminate a long chain, to stop the striping chain on the body color. To do this, the stripes should be made the same as described above and after starting on the body color, medium height links should be used in the chain. These medium height links will not make any change on the feeds but will continue all feeds as they are, whether they are in action or out of action. After the machine is running continuously on the body color and on the medium height links, a stop pin is employed in one of the links which raises the stop lever and

idles the chain wheel. This will then remain idle until it is put into action by a high link on the measuring chain. The measuring chain is a link chain on the outside sprocket and this will consist of as many low links as are required to make the desired amount of body fabric and one high link which will put the striping chain into action.

The production of vertical stripes, diagonals, diamonds, plaids and various types of figured patterns requires selective control of the needles at the various knitting feeds whereby selected needles may be raised to a knitting position or left at a tuck or welt level where they do not function to form stitches from the yarn supplied at a particular feed. In machines of this class the raising of the needles to a knitting level is accomplished by means of a pattern wheel mounted on the cam block directly over the clearing cam. The periphery of the pattern wheel is cut with angular slots spaced to conform with the slots or needle butts in the needle cylinder. The pattern wheel, Fig. 125, is mounted at an angle conforming to the slope of rise of a regular clearing cam and is free to turn. The driving force is supplied by the moving needles whose butts engage the cuts of the pat-

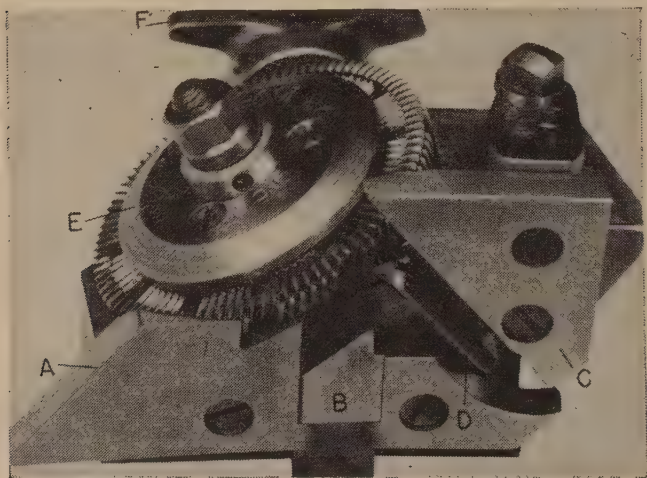


Fig. 125—Inside view of cam ring section from 24-inch, 32-feed S. S. W. machine showing design wheel, tuck bar and pull-down cam.

tern wheel in much the same manner as one gear drives another. The surface of the pattern wheel revolves upward in turning and carries with it the needles whose butts are engaged in the cuts, only when supporting jacks have been placed in the cuts in building the wheel. The needle butts, which enter the cuts in which no jacks are present, pass to the stitch cam at the tuck position where they take the yarn but do not rise to clear and subsequently cast off the stitch without knitting it into fabric.

Generally speaking, two types of patterns may be made on machines of this class. These are "knit-tuck" combinations or "knit-welt" combinations. The essential difference between a tuck stitch and the welt stitch is that in the tuck stitch the needle is high enough to take yarn but not high enough to clear the old stitch and knit. Two or more loops thus are placed on the needle to accumulate and be cast off simultaneously at a succeeding feed. The effect of tucking is to float the thread on the back of the fabric, the length of the float depending upon the number of adjacent needles which are in a tuck position. Fig. 126 is an enlarged view of a fabric from a pattern wheel machine on which the feeds have been threaded alternately black and white. The needles which have knitted the three center wales have been



Fig. 126—Diagram of stitch structure in a fabric figured by floating the black course on the back of a jersey fabric knitted with the feeds threaded alternately black and white.

caused to tuck the second and third black course. Knitting has occurred on these needles at the white feeds. The effect so formed is a white area with the black yarn floated on the back. It can readily be seen that, by utilizing this principle more fully, white figures more varied in character may be formed on a field of black and white or that by tucking at white feeds, the field may be made solid black.

The welt or float stitch forms an effect similar to the tuck stitch. In the forming of the welt stitch, however, the needle is too low to take the yarn in its hook and the yarn floats in a straight line between engaging needles and these floats tend to stabilize the fabric. While a group of needles at tuck position do not actually knit the yarn they engage, they exert strain upon it and cause the floats to be long in relation to the fabric.

How Tuck and Welt Stitches Are Formed

The mechanisms for controlling the needles for producing knit-tuck and knit-welt designs are contained in the stitch cam assembly illustrated at Fig. 125. The clearing cam *A* contains a sliding section *B* which is automatically raised or lowered by a tuck bar which extends through the cam block and has fastened on its outer end the cam segment *F* which is controlled from a pattern chain to bring the section *B* to the lower position in which it is shown or to raise it to its upper position. In the upper position, it clears all needles, and plain jersey fabric is made. When the section *B* is lowered, the needle butts come under control of the pattern wheel *E* and clearing and knitting depends entirely upon the pattern wheel. Those cuts which have jacks inserted will raise the needles engaged by them to full knitting position and these will take yarn and knit in descending under the stitch cam *C*. The needles which enter empty cuts in the pattern wheel have been raised by cam *A* to the tuck position and these will take yarn before reaching the stitch cam, but since they have not been raised high enough to clear the old stitch, they will move down the stitch cam and tuck. To produce the welt

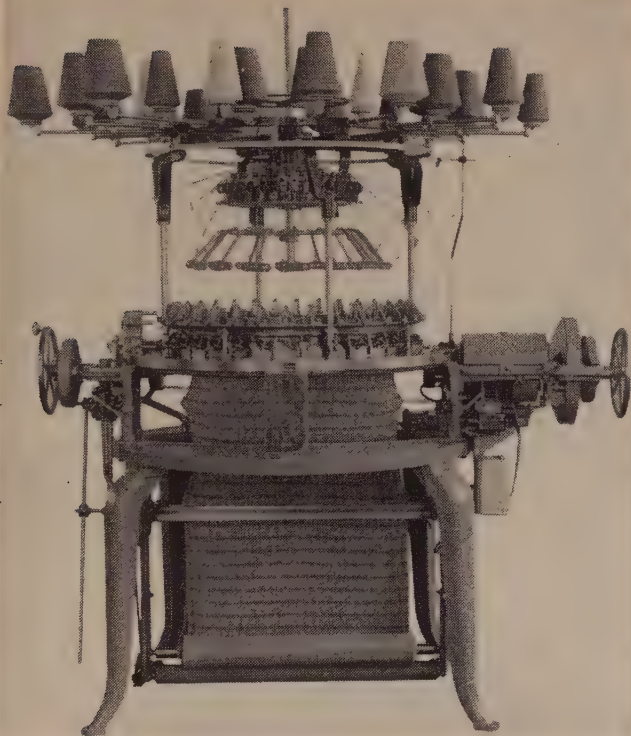


Fig. 127—Front view of Brinton 28-inch, 32-feed, 14-cut, 1,320-needle automatic selective striping machine, Style S. S. W. with wheels and tuck bars at all feeds.

or float stitch, the non-knitting needles must be cammed down at the yarn feeding point. To accomplish this the draw-down cam *D* is inserted. The effect of this cam is to depress the needles early so that no yarn is taken by their hooks. With the draw down cam *D* in action, knitting and welting occurs at that feed. With the draw down cam out of action, knitting and tucking will occur. Fig. 127 is a full front view of the Brinton automatic selective striping machine. This machine is 28 inches in diameter and has 32 feeds, each of which is equipped with a pattern wheel. Fig. 128 is a close-up view of the machine showing the control

mechanism which operates the striping fingers and tuck bars for horizontal striping, and pattern wheels which form the vertical stripes and the diagonal stripes between the

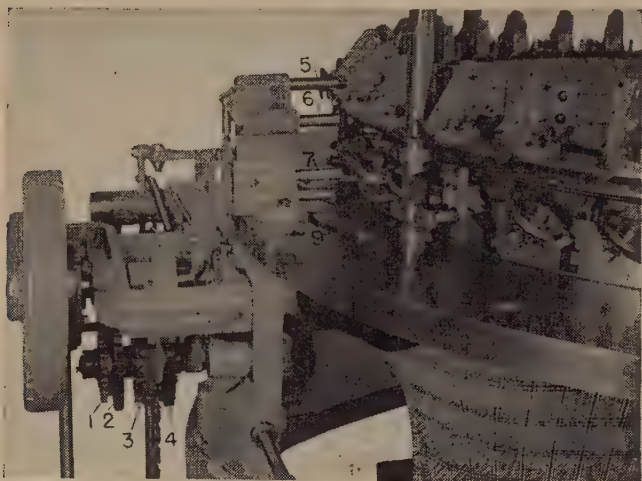


Fig. 128—Close-up view of Brinton selective striping machine showing automatic control mechanism.

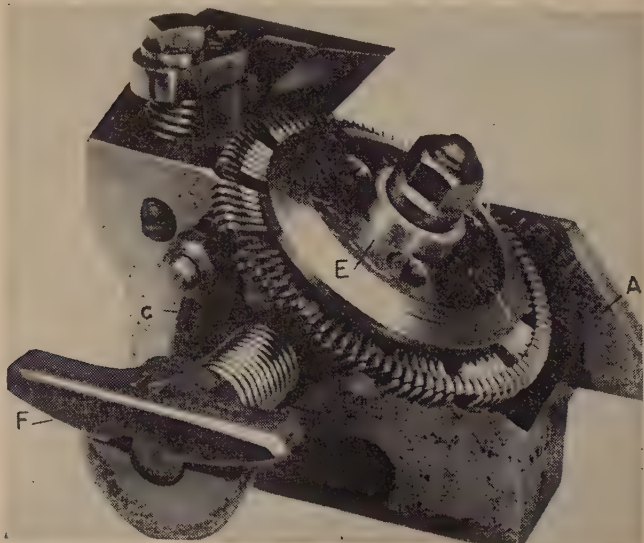


Fig. 129—Outside view of cam ring section from Brinton S. S. W. machine.

verticals. The upper plungers 5 and 6 control the striping fingers. Plungers 7 and 8 control the tuck bars. The insertion and removal of the plungers is controlled from chains and ratchets located at 1, 2, 3 and 4.

Design wheels for sinker-top machines are of the jack wheel type. The wheels are cut with a number of slots corresponding to the number of needles in the cylinder. If all of these slots are filled with jacks the wheel will cause all needles to raise and knit. If only certain slots are filled, certain needles only will be raised to the knitting position, and where the slots are open, the needles will pass through, and tuck or welt. In planning designs, several factors must be taken into consideration, such as the diameter of the machine, the number of needles, and the number of feeds.

Most modern machines using design wheels are of the multiple-feed type, with from 16 to 32 feeds. The length of the pattern field is governed by the number of feeds. The width of the pattern is a number which is a common factor of the number of cuts in the wheel and the number of needles in the cylinder. This number should also be divisible by many small numbers. Experience has shown that 24, 36 and 48 are the best for all around work. For example, 24 is divisible by 2, 3, 4, 6, 8 and 12; and 36 is divisible by 2, 3, 4, 6, 9, 12 and 18. Therefore, on an average machine, 18-inch diameter, 24 feeds, 14 needles per inch, a cylinder of 792 needles is generally used, with wheels of 96 cuts, which gives a pattern field 24 needles wide.

Many patterns are made with one wheel tucking on certain needles, and the following wheel knitting on the needles which are tucked by the first wheel. This is continued around the machine. If a vertical stripe three needles wide is to be made, the wheels will be set up with jacks in three slots, with the next three slots empty, and repeated all around the wheel. The first wheel is placed on the machine and the three needles which are raised by the wheel are marked. The second wheel is then placed on the machine and brought to the marked needles. The three open spaces in the second wheel are placed opposite to these needles, and the needles are pushed down through the open slots.

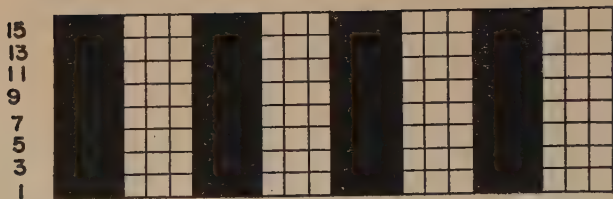


Fig. 130—Six-needle pattern repeated all around each wheel for 16 feeds; 792-needle cylinder, 96-cut wheels.

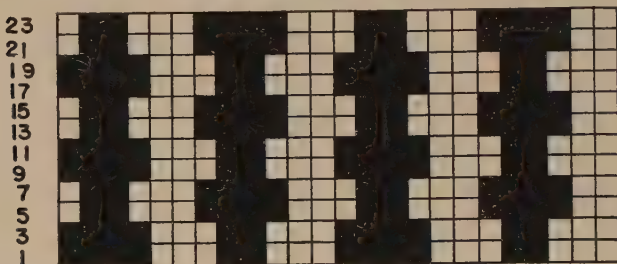


Fig. 131—Twelve-needle pattern for 24-feed machine; 792-needle cylinder, 96-cut wheels.

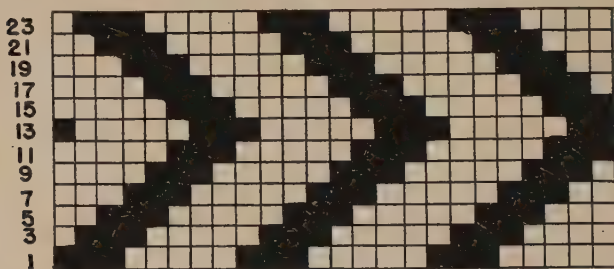


Fig. 132—Eight-needle pattern for 24-feed machine; 792-needle cylinder, 96-cut wheels.

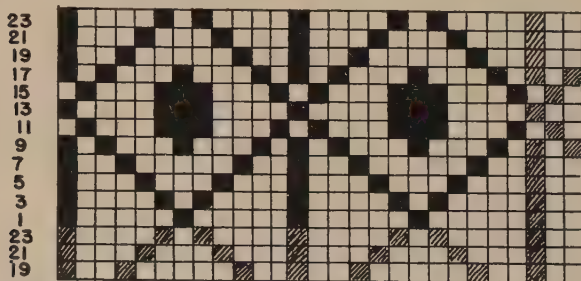


Fig. 133—Twelve-needle pattern for 24-feed machine; 792-needle cylinder, 96-cut wheels.

The third wheel is then placed the same as the first wheel, and the fourth wheel, the same as the second one, and this is continued until all wheels are set.

To lay out a pattern, use cross-section paper, and number the squares left to right, from one to the total number of needles in the pattern field. Number the squares from bottom up from one to the number of feeds. In laying out the pattern, figure on half the number of feeds only, that is 12 for a 24-feed machine, or eight for a 16-feed machine. This represents every other wheel on the machine, such as number 1, 3, 5, etc., and as the other wheels, 2, 4, 6, etc., are opposite to the first group, they may be read from the same layout.

Any combination of tuck and knit stitches which can be contained in 24 needles and 12 courses can be made on the machine previously referred to (18-inch, 24 feeds, 792 needles, 96-cut wheels). Figs. 130, 131, 132, 133 show some typical layouts. These can be duplicated to a certain extent on other machines of different diameters, numbers of needles, and number of feeds.

Diagonal Patterns

On multiple feed machines twill or diagonal patterns can be made by simply moving each wheel over one needle as shown in Fig. 134. However, in this case the design is limited to 12 needles—or one-half the number of feeds. If the number of the machine has 24 feeds, the wheels must divide evenly into a number 12 less or 12 more than the number in the cylinder. For example a 24-feed machine with a cylinder containing 792 needles would require wheels which would divide equally into 780 to make diagonals in one direction; or into 804 to make diagonals in the opposite direction. Wheels of 78 cuts would divide equally into 780, and wheels of 67 cuts would divide into 804.

In some cases it is not possible to get wheels which will divide properly, and in the above case wheels of 67 cuts would be too small to use. To overcome this, the number of feeds on the machine may be reduced. If reduced to 20,

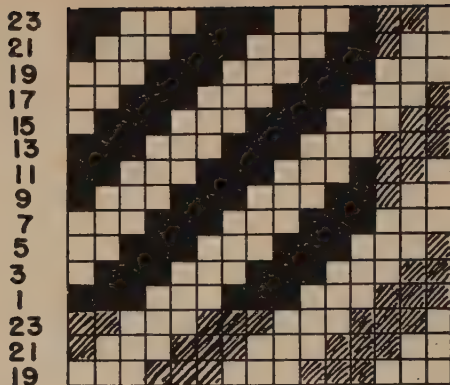


Fig. 134—Twelve-needle diagonal pattern for 24-feed machine; 792-needle cylinder, 96-cut wheels.

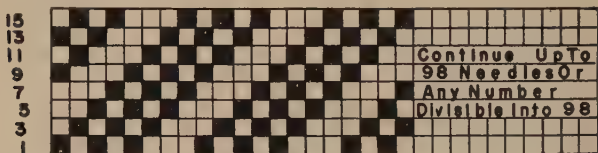


Fig. 135—Diagonal pattern for 16-feed machine; 792-needle cylinder, 98-cut wheels (divide into 784).

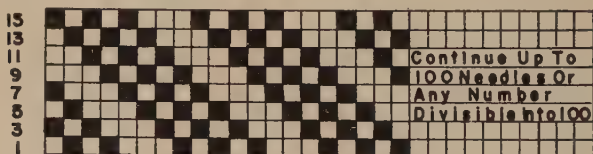


Fig. 136—Diagonal pattern for 16-feed machine; 792-needle cylinder, 100-cut wheels (divide into 800).

a 792-needle cylinder the wheels would have to divide into 782 (ten less) and 802 (ten more) than the number in the cylinder. If reduced to 16 feeds, the wheels would divide into 784 and 800. If the twill is desired in both directions on a 792-needle cylinder then it would be advisable to reduce the machine to 16 feeds—and use wheels of 98 and 100 cuts. The wheels would then be set over one needle to the left on the 98-cut wheels, or one needle to the right on the 100-cut wheels. Figs. 135 and 136 are examples of patterns of this type.

Figured Patterns

In laying out diamonds, squares, or irregular patterns, a different method is used. It is necessary to have a pattern field which will divide evenly into the wheel and also into the cylinder. The number of cuts in the wheel must also divide the number of needles in the cylinder and leave a remainder equal to the number of needles in the pattern field. Examples follow:

Needles in Cylinder	Cuts in Wheel	Pattern Field
720	100	20
792	96	24
1,008	108	36

A 100-cut wheel on a 720-needle cylinder will revolve around the cylinder seven times and leave a remainder of 20 needles. This is the pattern width. If it is assumed that the cylinder is made up of blocks of 20 needles each, it will be obvious that when the wheel has made seven full revolutions, the first block of 20 on the wheel will act on the last block of 20 needles in the cylinder. This, of course, will bring the next block of 20 in the wheel on the first block of 20 needles in the cylinder. In the meantime the wheels on the following feeds have acted on the same needles as the first wheel, so that when the second block on the wheel reaches the first block on the cylinder it will be four, eight, 12 or more courses lower, depending on the number of feeds.

The depth of the pattern field depends on the number of feeds. In the above example of a 100-cut wheel, with a 20-needle pattern field, the pattern field divides five times into the 100 cuts of the wheel. As every other wheel is considered, eight wheels on a 16-feed or 12 wheels on a 24-feed machine are used in the depth of the pattern. As there are five blocks on the wheel, on a 16-feed machine the depth of the field would be five by eight or 40 courses. On a 24-feed machine the depth would be five by 12 or 60 courses. The same system will apply to any other number of feeds.

For example, with 108-cut wheels on 2.4 feeds, 1,008 needles, the pattern field is 36.

$$36 \times 3 = 108$$

$$\times 12 \text{ feeds}$$

$$36 \times 36 = \text{pattern field}$$

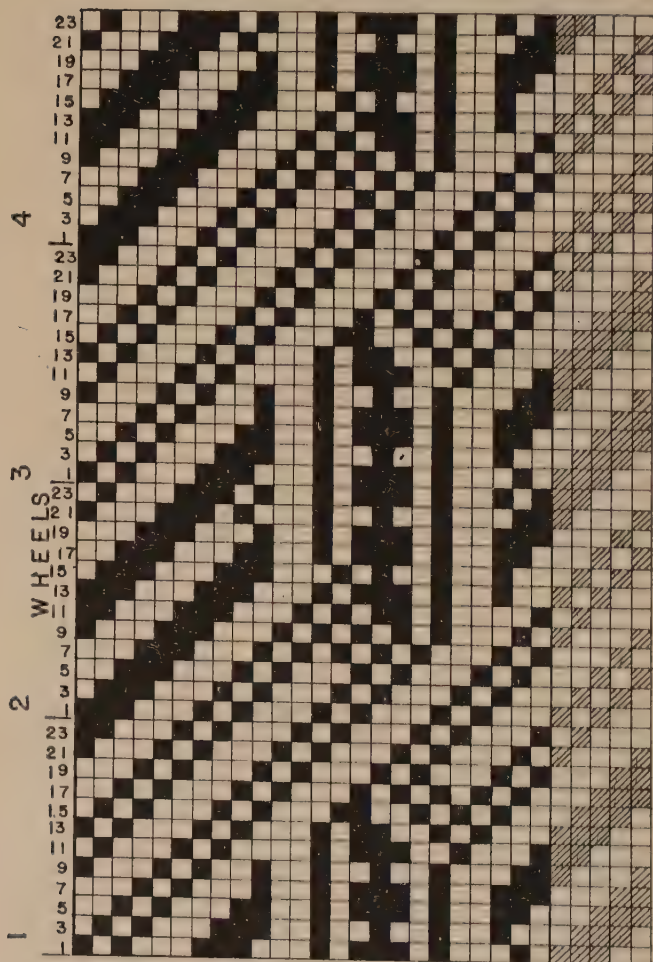


Fig. 137—Twenty-four by 48 pattern for 24-feed machine; 792-needle cylinder, 96-cut wheels.

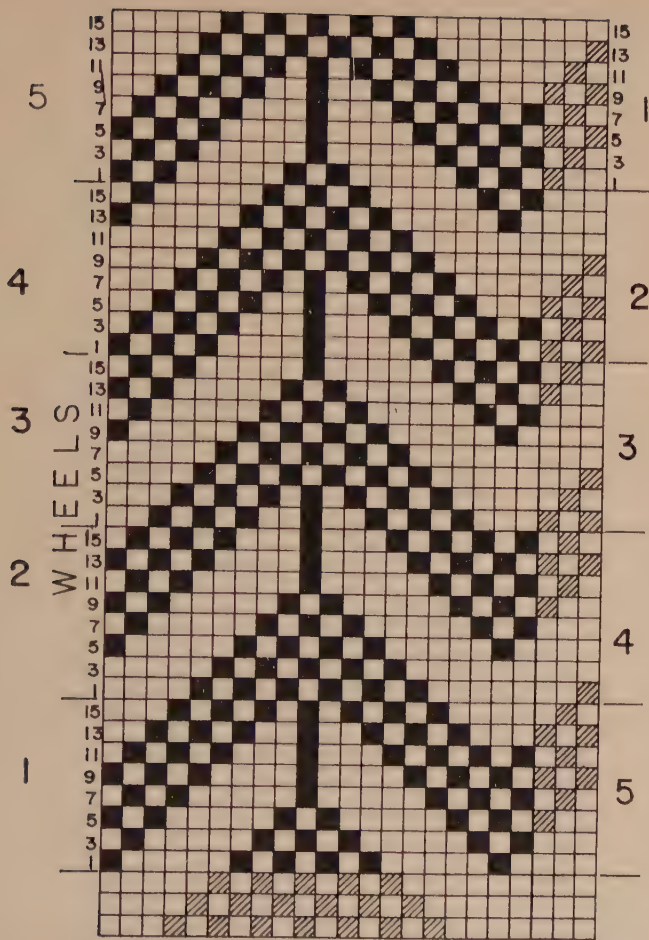


Fig. 138.—Twenty by 40 needle pattern for 24-feed machine; 720 needles, 100-cut wheels. Also 680-needle cylinder and 100-cut wheels, reading from top down.

To lay out a pattern, use cross-section paper and number the spaces from one to the total width of the repeat. Number the spaces vertically, starting at the bottom and continue to the total number of wheels being considered. This is usually half the number on the machine. If there are five patterns on the wheel, the vertical numbers will be re-

peated five times or as many times as there are patterns or blocks on the wheel. Figs. 137, 138 and 139 are typical examples.

To read the pattern shown in Fig. 138, start at the bottom on the line numbered 1, and read from left to right for the first 20 cuts on the first wheel. Then go to the next line above marked 1, and read across for the next 20. Proceed to each of the remaining lines marked 1 until the 100 cuts in the wheel are completed. The second wheel will be filled opposite to the first.

Proceed in the same way for the third wheel. Start at the

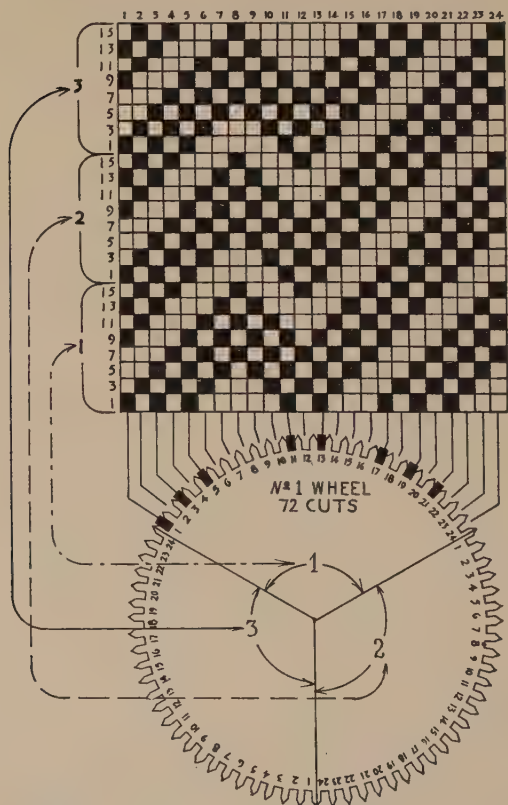


Fig. 139—Pattern on 24 wales and 16 courses; 72-cut wheels, 672-needle cylinder, 16 feeds.

line marked 3, and read across for the first 20 cuts, following in order with each line marked 3. The fourth wheel will be opposite to No. 3. Follow the same method for wheels 5 to 15, and fill wheels 6 to 16 exactly opposite. In other words, the wheels are read in pairs, the uneven numbers being filled according to the layout, and the even numbers exactly opposite. Where the spaces are filled in No. 1 wheel, they will be open in No. 2 wheel, and vice versa. This will continue with each pair, 3-4, 5-6, 7-8, etc. On a 24-feed machine, the width of the pattern will be the same, but the vertical numbers of the wheels will then run from one to 23, and will be read in the same manner described above.

After the wheels are all filled and ready to put on the machine, mark a needle in the cylinder to serve as a starting point. Raise the needles which would interfere with placing the wheel close to the cylinder, and set No. 1 wheel on the machine so it turns freely. Place the marked needle in the first slot of the wheel which represents the first place on No. 1 line of Fig. 139. Then push down the remaining needles into their respective slots in the wheel and turn the machine so the next feed comes opposite to the marked needle. Take the No. 2 wheel, that is the one filled opposite to the No. 1 wheel, and place this wheel on the machine the same as the first one. Then place the No. 3 and No. 4 wheels on the next two feeds starting with the marked needle, and continue until all wheels are on the machine.

The same patterns can be made on a cylinder and wheels in which the pattern width is not a remainder but an excess. For example, using a 100-cut wheel on a 680-needle cylinder, the same result could be obtained as by the example given of using a 100-cut wheel on a 720-needle cylinder. In each case the pattern width is 20 needles. The pattern field is laid out exactly the same as in the first case, numbering from the bottom, but when reading the pattern, and filling the wheels, read from top down. Refer to Fig. 138 and read the first wheel from left to right beginning with the top block, marked 1 at the right. Proceed to the next lower block, and continue to the bottom, following the

numbers at the right of the figure. Continue with No. 3 wheel, starting at the top and follow with the balance of the wheels, always starting with the top block and reading to the bottom.

It is also possible to make similar designs when the wheel does not divide into the cylinder, and leave a remainder or an excess of the exact pattern width. However, the remainder must always be equal to two or more of the pattern widths. If the pattern width is 20 needles, the remainder must be 40 or 60. An example of this is the use of a 100-cut wheel on a 640-needle cylinder. The pattern width is 20, and as 100 divides into 640 six times and leaves 40 over. This remainder is equal to two of the pattern widths of 20 needles each. The following are similar examples:

Cylinder	Wheel	Remainder	Pattern Width
832 N.	80 cuts	32	16
888 "	120 "	48	24
800 "	120 "	40	20

The pattern field is laid out the same as shown in Figs. 137 and 138. However, the reading is different on account of the fact that there are two pattern widths left over instead of one. In reading the pattern, start at the bottom for the first block on the wheel, and then omit the next two blocks, and read the fourth from the bottom. Next read the second block from the bottom, followed by the top block, and end-

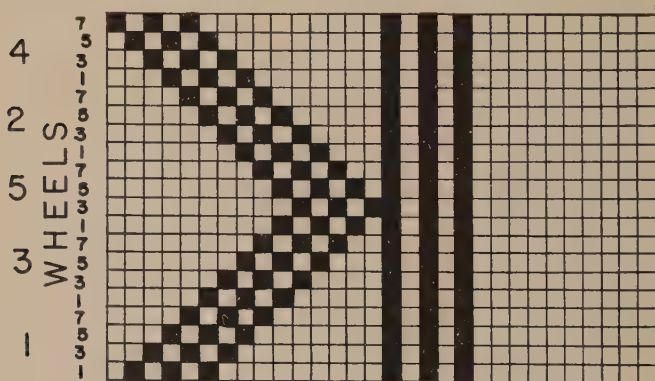


Fig. 140—Twenty by 20 pattern for eight-feed machine; 640-needle cylinder, 100-cut wheels.

ing with the middle block. Fig. 140 shows, with numbers at the left, how the blocks are read in this type of pattern.

The foregoing explanations all apply to using two colors in one course of knitting, hence the necessity of considering the wheels in pairs or groups of two. On some tuck-stitch patterns, or where one color is used, it is not necessary to consider the wheels in groups of two, and a pattern can be

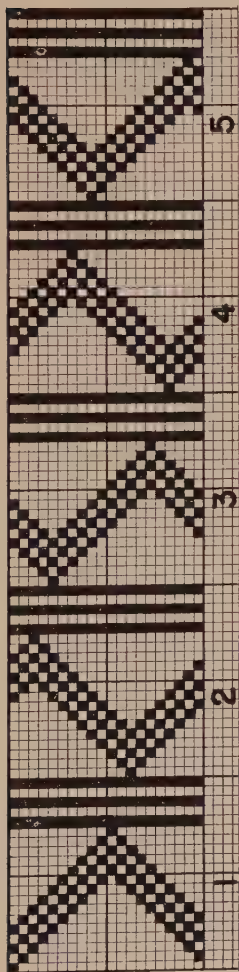


Fig. 140-A—Effect produced in fabric on an eight-feed machine with 640 needles in the cylinder and patternwheels built according to the design shown in *Fig. 140*. The wheels are 100-cut and thus contain five pattern divisions of 20 cuts each.

laid out to use all the wheels on the machine. In this case the pattern will be laid out the same as explained, but the depth of the field will be doubled, as all wheels will be considered. The pattern width will be the same, and in laying out the pattern, number the wheels consecutively (1, 2, 3, 4) up to the total number on the machine.

Three-Color Patterns

A three-color pattern must be laid out somewhat differently from the two-color patterns. Instead of groups of two, the wheels must be considered in groups of three to get three colors in each course of knitting. This requires a number of feeds divisible by three such as 12, 15, 24, 30. In some cases it will be necessary to block out feeds on the machine to leave a number divisible by three. For example, a 16-feed machine would have to be operated as a 15-feed machine.

On a 24-feed machine, lay out the pattern for eight courses only, the width of the field being the same as on the two-color patterns. It is best to use colors in laying out the pattern, to correspond to the different colors of yarn to be used. If a red, white and black pattern is being made, it will be necessary to run a red yarn in the first feed, a white yarn in the second feed, and a black yarn in the third feed, and repeat every three feeds. Reading the pattern, the first line at the bottom will represent the first three feeds, the second line the next three, and so on.

In reading the first wheel, the red squares will represent the filled cuts in the wheel, all others being open. On the second wheel, the white squares will be the filled cuts, all others being open. On the third wheel, the black squares will be the filled cuts, all others being open. In other words, where the red square is shown, the red yarn will knit on this needle, and float to the next red square, behind the other two yarns. This will be followed by the balance of the wheels in groups of three (see Fig. 141). Any of the two-color patterns can be duplicated in three colors by following this procedure. On jersey-type machines only small patterns

can be made on account of the long floats which result from each yarn floating behind the other two yarns. On rib machines this will not interfere, as the float yarn is knit in by the dial needles.

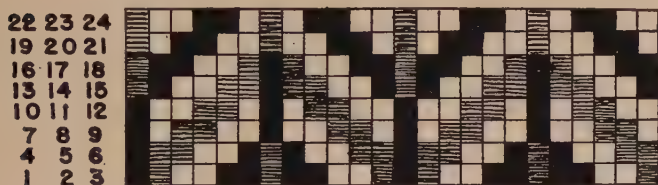


Fig. 141—Three-color pattern for a 24-feed machine; 792-needle cylinder, 96-cut wheels.

Sinker Wheels

Sinker wheels are laid out the same as the wheels which operate on the cylinder needles, except that all wheels on the machine are considered. For example, if 12 feeds have wheels on the sinkers, the vertical spaces will be numbered from one to 12 consecutively, because these wheels are considered individually and not in groups.

Dial Wheels

Wheels for use on dials of rib machines are figured the same as cylinder wheels. The only difference is in filling the wheels with the jacks. On cylinder wheels, or sinker wheels, these are filled from left to right, or clockwise as shown in Fig. 139. On dial wheels for rib machines, the wheels stand in a vertical position so that the opposite side of the wheel comes in contact with the needles causing the wheel to turn in the opposite direction. Therefore on dial wheels the jacks should be put in the wheels from right to left or anti-clockwise.

Chapter XI. Advanced Latch Needle Fabrics

THE development of the three-position pattern wheel (Brinton Patent No. 2,000,837) marked an important advance in the art of knitted fabric production. The three-position wheel provides three-level control of the needles at a single feed. These positions are knitting, welting, and tucking. The three-position wheel is in reality two wheels mounted together on the same axis. The upper wheel *A*, Fig. 142, selects needles and disposes them in knit-tuck position. The lower wheel *B* controls needles in the welt-tuck positions. It should be emphasized that both of these positions may be utilized in producing the fabrics described in the foregoing section with a single pattern wheel, but with the single wheel, three-level control cannot be achieved simultaneously at the same feed. The single wheel is capable of producing knit-tuck at a given feed or in combination with the draw down cam, may produce knit-welt patterns, but knitting, welting, and tucking are not possible at the same feed where the single wheel is used.

The three-position wheel makes possible the production of a variety of knitted fabrics with patterns in full color without the presence of floating yarn on the back. The lower wheel functions to raise needles to tuck position where they are caused to take on and hold the yarn which would other-

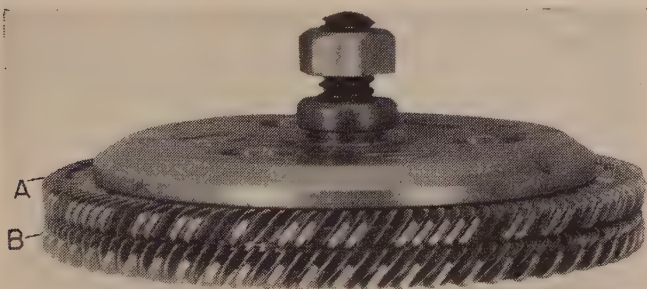


Fig. 142—Three-position pattern wheel. The top wheel controls needles to produce pattern work. The lower wheel raises needles to tuck position and serve to bind floating threads to the back of the cloth.

wise float, and cause it to be bound to the back of the cloth in such a manner that it will not show on the face. In operation, the upper wheel therefore functions to raise selected needles to a knitting position. The lower wheel selects, from the needles not raised to knit, those needles which are to take yarn between the needles which do knit. The yarn so taken will be laid into the fabric (not knitted). This feature makes possible a much wider disposition or separation of the pattern elements. It will be observed that in all patterns which have preceded, the colors have been closely spaced to avoid the formation of long floats on the back of the fabric. With three-level control this distance is not limited.

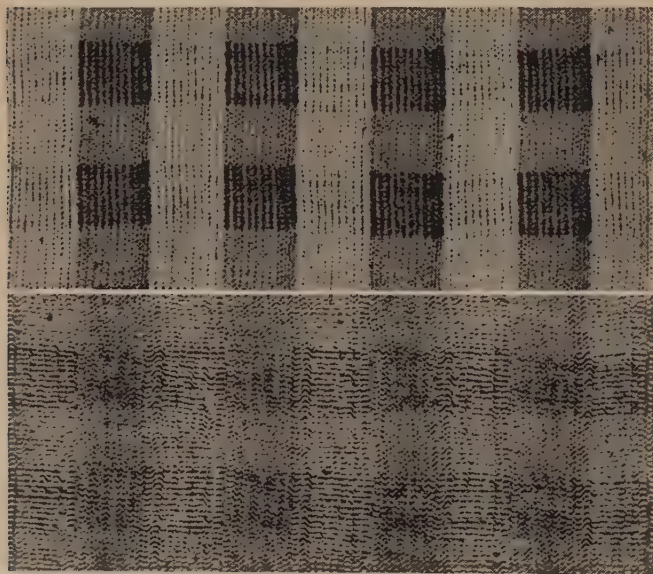


Fig. 143—Fabric knitted with three-level pattern wheels. Above is the face; lower portion illustrates the back, with all yarn bound to the fabric.

Fig. 143 is a striped fabric in which yarn has been knitted continuously on ten needles separated by ten needles which have been controlled on the same courses to bind the yarn on the back. Assuming that the white yarn is knitted at

feeds 1, 3, 5, 7, 9, etc., each of these would carry wheels built as follows: upper wheels—10 in 10 out; lower wheels—1 in 1 out, or 1 in 2 out, 1 in 3 out, etc. The wheels for all even feeds would be opposite to the above.

The block pattern is obtained by striping in gray in place of blue at the even feeds. The advantages of this system of knitting can easily be realized by observing the formation of the back side of the cloth shown also in Fig. 143. All yarn which has not been knitted into the face is bound firmly to the back where it not only is hidden from view, but where it serves to give weight, firmness, and stability. Actually, two courses are required to make one complete course of knitting in the face fabric, but a fabric of finer texture is produced than is possible for plain jersey cloths of equal

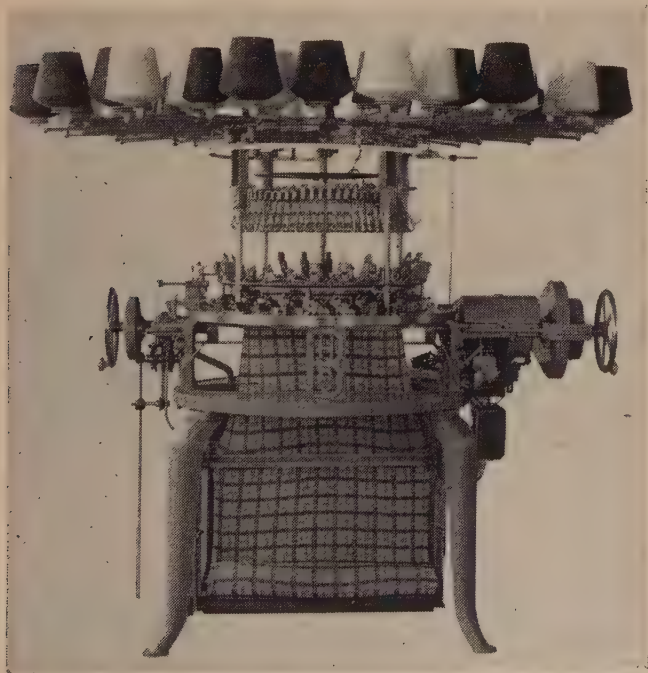


Fig. 144—Three-position design wheel machine style S. T. W. Y. This machine is equipped with design wheels at all feeds, four-color yarn changers on 12 alternate feeds, automatic tuck bars, pull-down cams, free wheeling, take-up reel, and 64-end bobbin table.

weight. This principle of fabric construction makes it practical to produce wide vertical stripes in full color; and in combination with the horizontal striping attachment, all kinds of stripes, plaids and other geometric forms may be knitted into the cloth to present much the same appearance and quality as woven fabric. Two views of the Brinton three-position design wheel machine are given at Figs. 144

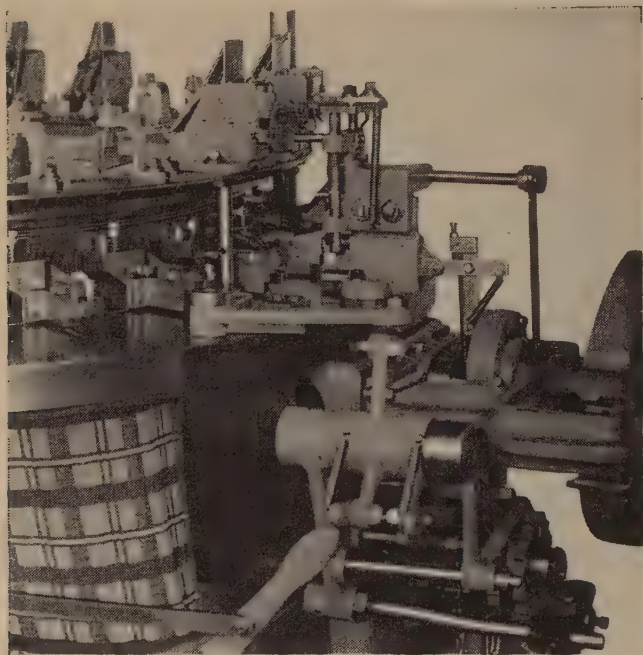


Fig. 145—View of the automatic side of the Brinton S. T. W. Y. machine, showing controls for yarn changers and tuck bars.

and 145. Fig. 144 shows the front view. This machine is equipped with design wheels at all feeds. In addition, 16 alternate feeds are equipped with yarn changers, automatic tuck bars, and pull-down cams. Other features include free wheeling, take-up reel, and a 65-end yarn table. Fig. 145 shows the automatic side with the control chains provided to actuate the striper and tuck bars.

The principles involved in knitting with three-level pat-

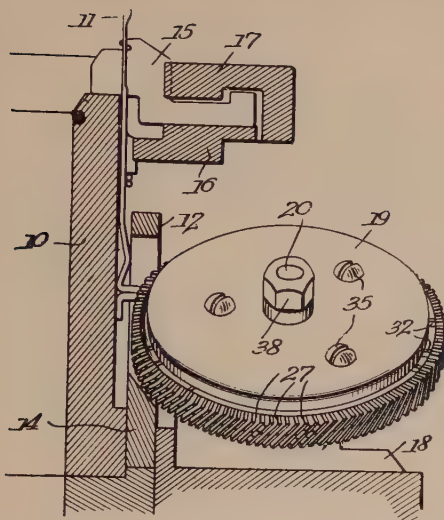


Fig. 146—Section of needle cylinder, showing location of three-position design wheel.

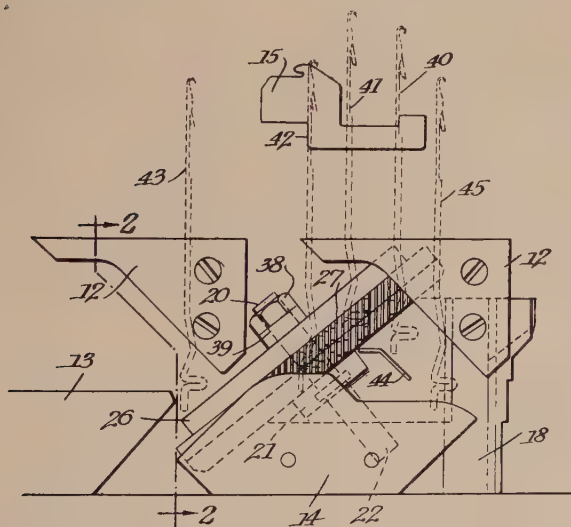


Fig. 147—Profile view of the knitting cams showing three-position control of the needles for knit-tuck and tuck-welt patterns.

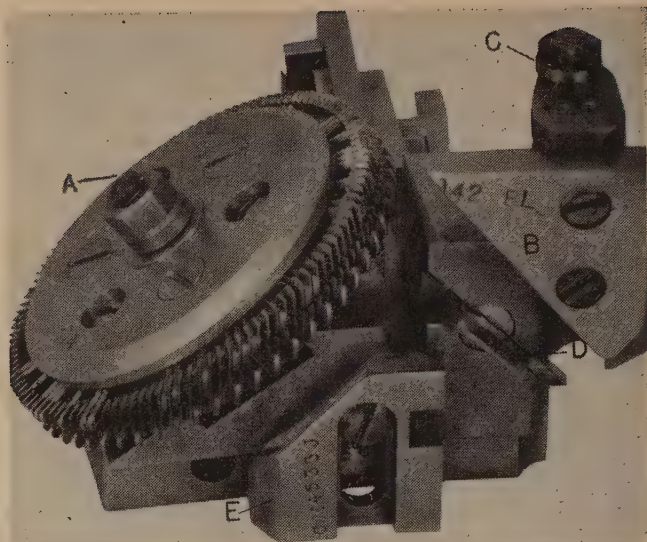


Fig. 148—Cam section from three-position pattern wheel machine showing tuck bar and pull-down cam which separates the tuck and welt needles.

tern wheels are illustrated at Figs. 146, 147, and 148. Fig. 146 is a section view of the needle cylinder 10, sinker head 16, and sinker cap 17, with the latch needle 11, and sinker 15 in knitting position. The pattern wheel is made up of two units with angular cuts on their outer surfaces. The units are mounted concentrically and are free to turn on the stud 20. In preparing the wheels, small segments known as jacks have been placed in a portion of the cuts 27. The presence of one of these in the upper wheel will result in raising the needle engaged by it to a full knitting position. The wheel is adjusted at 38 to bring it almost in contact with the walls of the needle cylinder.

A profile view of the wheel and knitting cams is shown at Fig. 147. The angular cuts 27 are now upright and parallel with the needle. When a needle butt enters a cut in the pattern wheel which has no jack in either the upper or lower position, its elevation is not affected by the wheel but is determined by the raising cam 14. At this level it will pass under and be depressed by the draw down cam 44.

This cam performs a vital function since it is situated under the yarn feeding point. In depressing the needle, it is prevented from taking yarn. It will therefore take up position 45, Fig. 147; *this is the welt position*. The presence of a jack in the upper wheel will cause it to rise to position 41 before it is disengaged; *this is the clearing position*. The needle will take yarn and knit in passing under the stitch cam 12. The needle 40 is in *tuck position*. Its hook is high enough to take yarn but since it has not been cleared it will fail to knit on passing under the stitch cam 12. The tuck position is obtained by placing a jack in the lower wheel. The jack raises the needle butt high enough to pass over the draw down cam 44, but not high enough to clear the latch. This position is used to bind floating yarn to the back of the cloth.

Ordinarily the lower wheel is built with one jack in, one jack out, for the odd feeds 1, 5, 9, etc. At the odd feeds 3, 7, 11 the lower wheels should be filled directly opposite, i. e., one out, one in. This disperses the binding points and makes for a better fabric. In certain instances it may be desirable to float the yarn over two or more needles. If this is to be done, a twill order of binding should be adopted. Fig. 148 is a view of the cam section showing the three-position wheel *A*. It will be seen that the lower wheel contains jacks in alternate cuts. Other important parts of this assembly are the stitch cam *B* with adjusting screw *C*. The sliding clearing cam *E* is shown in its lowest position. Without the pattern wheel, all needle butts would pass over this cam and be depressed to welt position by the draw down cam *D*. With the section *E* raised, the machine may be operated to make plain jersey or to produce knit-tuck patterns.

The new equipment for knitting floatless fabric offers new possibilities for extending the uses of knitted fabric into fields for which they formerly were not considered well adapted. Fig. 149 is a pattern in black and white in which a floral stripe has been spaced ten needles away from a simple straight line and stitch-and-stitch effect to produce a fabric suitable for slip covers, Fig. 149A. This pattern is

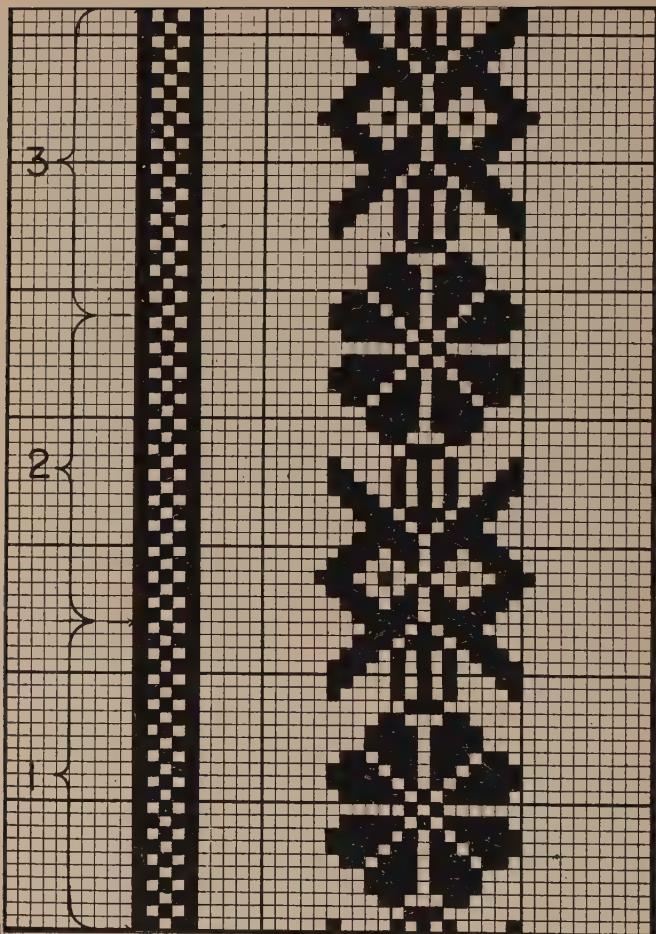


Fig. 149—Design for 24-inch machine (1,360 needles, 120-cut pattern wheels, machine cut 18, yarn number 18s). Black squares in the design represent needles up to all odd feeds, 1, 3, 5, 7, etc. Even feeds (2, 4, 6, 8, etc.) are opposite to the odds. Lower wheels are filled one in, one out alternating at the odd feeds. Lower wheels at even feeds are opposite to the odds.

laid out on 40 wales and was knitted on a 24-inch, 24-feed machine containing 1,360 needles. The feeds were equipped with 120-cut pattern wheels with the feeds threaded alternately one white, one color. Shaded squares in Fig. 149

represent needles up at odd feeds. Wheels at even feeds are opposite to the odds. The lower wheels are filled one in, one out, alternating. The pattern repeats with three pattern divisions. These are indicated by the numbers 1, 2, 3 on the left margin of Fig. 149. The 120-cut pattern wheel for feed No. 1 is built by reading line No. 1 in the design for 40 stitches, moving to line No. 1 in the second division for the second 40 stitches, and then to line No. 1 in the third division for the third 40 stitches, making 120 in all. This completes one revolution of the pattern wheel. The upper



Fig. 149A—Fabric knitted from the pattern shown at Fig. 149.

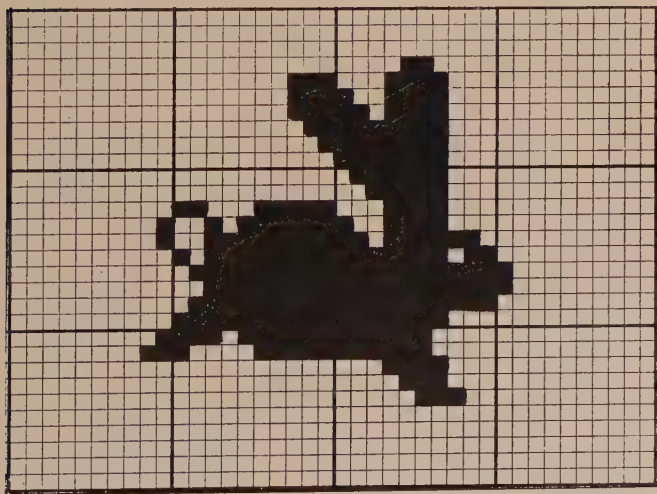


Fig. 150—Pattern for 24-feed, three-level pattern wheel machine (20-cut wheels, 1,360 needles, pattern field 40 x 36). Lower wheels are filled one in, three out to tie in the filling in one-three twill order on the back.

wheel for feed No. 2 is filled by following the same line and inserting jacks in reverse order to those in wheel No. 1.

Fig. 150 is a layout on 40 x 36 representing 40 wales and 72 courses of knitting. The pattern is adaptable to a 24-feed machine with 1,360 needles and 120-cut pattern wheels. In filling the upper wheels it is necessary to read three times through the design; moving up one-third repeat each time to completely fill the 120-cut wheel. The effect in fabric is seen at Fig. 150A. The three pattern divisions, consisting of three vertical lines of figures, each offset one-third repeat in depth, serve to disperse the figures over the entire fabric and contribute to balancing the total effect. This fabric suggests a use in children's clothing.

The design capacity of a 24-feed 1,380-needle machine has been utilized to produce a floral pattern in Fig. 151; the design area here was determined as follows: 1,380 divided by 120=11 full repeats of the wheel for each turn of the cylinder plus a remainder of 60. The remainder, 60, is a factor of the pattern wheel, 120, and also of the total needles, 1,380, and can therefore be used to produce a non-spiral design. The pattern wheels contain 120 cuts, or two pattern divisions of 60 cuts each. The depth of the design is then determined as two times the number of feeds, 24, or 48 courses. The wheels for feeds one and two are built from Fig. 151 by following line No. 1 for 60 cuts, then



Fig. 150A—Fabric knitted from Fig. 150.

moving to line No. 13 for the second 60 cuts. Wheels for the succeeding feeds are filled by reading the appropriate lines in the pattern. The effect produced in fabric is shown at Fig. 151A. Normally this pattern would be knitted with the feeds threaded one white, one color. The use of alternate bands of dark yarn assists in studying the alignment of the design elements. The use of two pattern divisions has served the purpose of offsetting the figures with respect to one another, and in this manner the whole effect is improved.

In Fig. 152, a pattern has been selected to illustrate more fully how depth can be achieved in design wheel knitting.

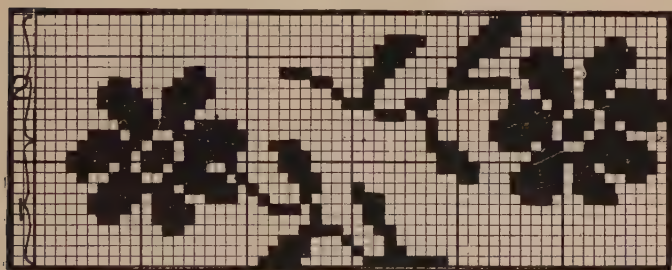


Fig. 151—Design for floatless fabric adaptable to a 24-feed machine containing 1,380 needles and 120-cut wheels. Feeds are to be threaded one white, one color. Fill lower wheels one in, one out alternating.



Fig. 151A—Floatless fabric knitted from Fig. 151.

total depth. This area has been utilized to produce the cable effect in fabric, Fig. 152A. This depth may be further extended for a given set of conditions by reducing the width of the pattern division. For example, 20 needles might be adopted as the width of the pattern division. This number is contained six times in the 120-cut wheel, and the depth of the pattern would then be 6×32 or 192 courses of knitting, etc. By further reducing the width it is possible to make patterns extending through many knitting courses.

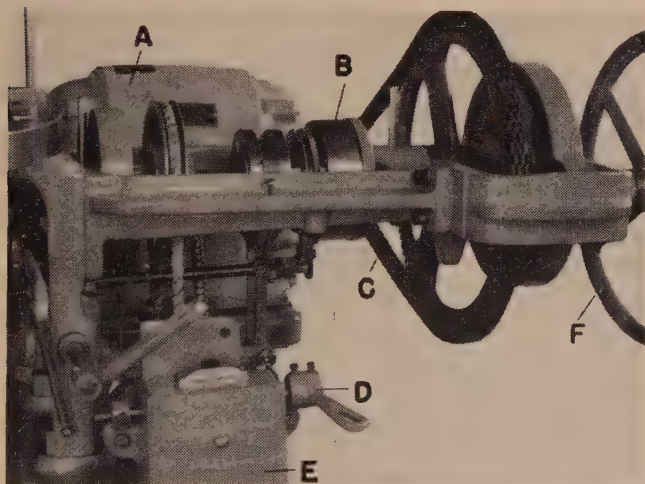


Fig. 153—Close-up view of the right side of Brinton circular knitting machine showing construction of individual motor drive, Link-Belt chain, free wheeling mechanism and floating disc clutch.

Chapter XII. Color Principles And Harmony

In Knitted Fabrics

EITHER form, color, or combinations of form and color may be used to decorate knitted fabrics. Form is surface decoration usually consisting of geometric effects, or combinations of vertical, horizontal and diagonal lines. Thus form is produced by the stitch formation and the adornment of the fabric is due to the manner in which the loops are joined and to the amount of light reflected from different parts of the pattern. In many varieties of fabrics ranging from plain jersey and other simple cloths to complicated jacquards, decoration is due entirely to form and color.

In knitwear design the primary function of color is to add brightness and cheerfulness to the fabric and to improve the quality of the design. In many varieties of fabrics for knitwear the patterns are frequently combinations of fancy colors in a plain cloth. The jersey fabric may be taken as a specific example of this. In pile fabrics, the texture may be completely concealed. Thus in many fabrics color forms the outstanding decorative feature with stitch merely forming the structure of the cloth. Frequently a good scheme of coloring will redeem a poor design and make the fabric sell, while a poor system of coloring will spoil an excellent design. Thus a good system of coloring is often of more importance than form and designers must study colors very carefully to see that the patterns which they turn out contain harmonious color combinations.

A third method of applying color to knit fabric is known as color and stitch effects. In these the pattern produced is due to a combination of a particular stitch with a specific order of coloring. Summing up, it may be said that color serves a three-fold purpose in knit goods designing: *first*, color may be the predominant decorative feature of the pattern; *second*, color may be used to supplement form, thereby adding precision and beauty to the pattern; *third*,

color may be combined with form to produce color effects in which the pattern depends both on the method of intersection of color and loop formation.

The application of color to textiles is an art in itself as the ordinary principles of decorative art will not apply to knitted fabrics because cotton, wool, silk, nylon and rayon all have different characteristics which must be known in order to intelligently apply color to textile products fabricated from them. Colored cotton goods, while bright and clear, are comparatively non-lustrous unless the yarn has been mercerized. Silk fabrics can be recognized by their luster, while woolens are distinguishable by depth and saturation of hue. Rayon fibers dye with many of the characteristics of silk. The differences mentioned are due to the physical formation and characteristics of the various yarns or fibers. Silk is almost transparent and shines like a smooth glass rod when light falls upon it. Wool is solid and non-transparent in the center but its outer surface consists of many semi-transparent scales which reflect light with a minimum amount of dispersion, and give to the wool a lustrous appearance. Cotton is not transparent. It absorbs light freely while what light is reflected is so broken up that the color suffers in saturation and brightness. Features of a silk coloring are luster, brilliance and richness. Features of a wool coloring are fullness and depth of hue which give a bloom and saturation not obtainable in other fibers. Cotton colorings are somewhat dull and flat. They do not have the brightness of silk or the synthetics.

Three things determine the color of an object: first, the nature of the light; second, the physical properties of the material on which light falls; third, the power of the observer's eye. There are two theories of color which are generally known as the "Light" theory and the "Pigment" theory. The pigment theory is used in the decorative arts and is the one in which we are interested. It is a process of subtraction, since one color counteracts or absorbs the other when they are mixed.

In the pigment theory of coloring, red, yellow, and blue are taken as the primary colors because they cannot be

obtained by mixing with other pigment colors. Theoretically, every possible shade and hue of color can be obtained by mixing these three colors in varying proportions and adding varying amounts of white or black. By mixing two primary colors in equal proportions a secondary color is obtained. Tertiary colors are formed by mixing two secondary colors in equal proportions. Colors formed by mixing two or more primary colors are called compound colors.

The following table shows the secondary and tertiary colors and how they are formed:

Primary Colors

Red
Yellow
Blue

Secondary Colors

Orange (Red plus Yellow)
Green (Yellow plus Blue)
Purple (Blue plus Red)

Tertiary Colors

Citron (Orange plus Green or 2Y plus R plus B)
Olive (Green plus Purple or 2B plus R plus Y)
Russet (Purple plus Orange or 2R plus B plus Y)

The hue or tone of a compound color is determined by the proportionate qualities of the primary colors which it contains. For example, to secure a reddish orange, red must be the predominant color and yellow the subordinate color. While to secure a yellowish orange, the proportionate amounts of yellow and red make yellow the predominant color.

The tertiary shades are the most useful colors employed in textiles. As a rule they are used for the ground of fabrics while the primary and secondary colors are used to add brightness to the pattern. Purity, luminosity, and hue are the three constants of color. Pigment colors are never entirely pure because they contain more or less white light. When a color reaches a high percentage of purity it is said to be saturated. When fading takes place the color loses in purity.

Luminosity varies according to the amount of light which a color reflects. Yellow is the most luminous color, orange is second, and red is third. Purple is the least luminous color and blue is next to purple. The hue of a color is the predominant color in it. For instance, if green contains more yellow than blue it is a green with a yellow hue. The hue varies according to the wave length of the light rays. The sun gives off not only luminous rays but also strong invisible heat rays. White fabrics absorb the invisible rays but reflect the luminous rays, while black or dark colors not only retain more of the sun's heat than light colors and are consequently warmer. This explains why dark clothes are worn in Winter and light clothes in Summer.

Pigment colors may be modified in three ways: (1) They may be darkened in tone by mixing with black, hence a tone of a color is darker than the color itself. (2) They may be lightened in tint by mixing with white, hence a tint of a color is lighter than the color itself. (3) They may be changed in hue by mixing with another color. For instance, scarlet is obtained by adding a small amount of yellow to red and crimson is obtained by adding a small amount of blue to red. The amount which the hue is changed depends upon the proportionate quantities that are mixed, for as previously stated, the hue leans to the predominant color in the compound.

Black and white are of great value in textile coloring as modifiers of color. They mellow many color combinations and are frequently used to give clearness and precision to a pattern. Light colors appear bright and distinct on dark surfaces, while deep colors such as blue and purple show strong and clear on white materials. Thus black and white have a two-fold purpose in textile design for (a) by mixing them with other colors a variety of hues ranging from the lightest tints to the darkest tones are produced; and (b) by using black and white in the fabric they add precision and brightness to the colors employed.

Red is warm, aggressive, arousing and exciting when used in large quantities, but very effective when used in small amounts, especially with its contrasting color, green. Red

is the most brilliant and gorgeous of colors but it is so powerful that when used in large quantities it neutralizes the effect of adjacent colors. Red gives freshness, brightness and cheerfulness to fabrics. Red is decidedly useful to textile designers but it must not be used too profusely, and in many cases it must be modified in accordance with the depth of other colors that are used with it. Thus, derivatives of red such as pink, rose, scarlet, crimson, brown maroon, and russet are more frequently used in knit goods than the pure red is.

Shades and Tints

Derivatives of a color include those tints and tones which are obtained by mixing the pure color with various amounts of white or black, or by mixing it with another color. Yellow is the most luminous color and adds purity and brightness to a fabric. Because it is rich, bright and cheerful, yellow has the same relation to light or whiteness that blue has to darkness. Yellow lacks the luster of red and the mellowness of blue, but it possesses vividness. While blue appears to recede from the eye, yellow appears to advance toward the eye. When yellow is blended with light and medium grays or lavenders its lustre suffers, but when applied to dark blues, browns or blacks its vivid qualities are easily distinguished.

There are three factors to be considered in using primary colors: (a) the nature of the contrast which results when the colors are placed on light materials; (b) on medium grounds; and (c) on fabrics composed of dark colors.

Yellow is less distinct on the first but improves in strength on dark grounds and is only slightly changed when arranged side by side with medium shades. When blended with blue, yellow's derivatives comprise various shades of green. When blended with red its derivatives are a variety of scarlet and orange shades. When blended with gray, yellow produces many shades of drab, consequently, yellow is a very useful color for blending with other hues to produce compound colors. It is the only color that is agreeable in association with all colors.

Blue most nearly approaches gray in formal refinement and coolness. In dark tones blue is used for the ground of patterns. In medium shades it is used for mellowing other colors, while bright blues add freshness and force to a pattern. The "coldness" of the blue makes it useful in subduing the redness of some coloring for it has a tendency to neutralize the warm hue of red's darker derivatives such as maroon, brown and russet. Pure red and pure blue, especially when used in large quantities, do not harmonize but blue combines exceedingly well with the darker derivatives of red.

Pure blue, like red, is used very sparingly in knitwear, but its derivatives are important. When blue is mixed with black, indigo shades result, but when mixed with white the result is pale blues and peacock blues. Indigo shades are generally used when blue forms the ground of a pattern. However, blue is not a ground color that permits much diversity in shades, so when it is used for the ground, a good range of olives, browns and grays is important. Blue gives a marked contrast when combined with shades of the olive class because in them, yellow is the prevailing tint.

When tones and tints of blue are combined with tones and tints of red or yellow only a certain depth of blue harmonizes with a certain depth of brown or olive, and if one predominates over the other the pattern becomes deficient and unpleasing to the eye. Hence, it is absolutely necessary that the tints or tones combined have equal quantities of white or black. If the ground coloring of a pattern is strong and harsh, blue or green will in many cases add mellowness to it. If the ground coloring is dull, red, orange or yellow, if added in small quantities, will in many cases relieve the heaviness of coloring and add freshness to the pattern. The secondary colors possess properties that are quite distinct from the primaries from which they are formed. Although not as intense as the primary colors, they are nevertheless strong colors and must be handled judiciously if harmonious combinations are produced.

Orange is a mixture of yellow and red. It combines to a modified degree the characteristics of each. It is the glad

color, possessing the light of yellow and the sprightliness of red. Its strength causes it to suffer little impoverishment either in lustre or intensity from close association with certain shades. With colors of a reddish or yellowish hue, it undergoes the most marked degree of modification. With greens and blues and their derivatives, its quality is not noticeably diminished. Whether distributed on dark or light surfaces, it stands out with lustre and freshness and is one of the most appropriate colors for imparting brightness and a rich appearance to any color combination which lacks these qualities. Orange when mixed with black produces brownish olives that possess warmer characteristics than olives derived from yellow, but lack the strength and richness of the russet browns. They are useful as ground colors because they form contrasting combinations with shades of green. When orange is mixed with white, salmon and gold colors are formed. Salmon and gold tints combine satisfactorily with tints of either green or blue.

Green is the Summer color. It possesses the light of yellow combined with the coolness of blue. It is refreshing and restful. When coupled with the various tints and shades of red, harmonious and contrasting combinations are obtained. Many derivatives of green, such as myrtle green, olive green and dark green are used in textile fabrics. Pea-green tints are formed when white is added to green.

Purple is the combination of red and blue. It is the darkest color, the color of depth and gives a poignant effect when the red predominates, a more refined one with the blue predominating in the mixture. Purple's characterizing qualities are softness, bloom and richness of tone. Purple is generally combined with derivatives of yellow. The pansy is an example of the pronounced contrast which purple forms with pure yellow. Purple in conjunction with white may be used with combinations of fawns, olives, etc., to give bloom and richness to the combination.

Complementary colors are in the greatest possible contrast to each other. Fig. 154 shows how a chromatic circle can be made which indicates at a glance the primary and secondary colors that are complementary to each other. Thus



Fig. 154—Color circle indicating the primary and secondary colors which are complementary to each other.

it will be seen that red is complementary to green, orange to blue, and yellow to purple. This circle also shows that if a reddish orange is used it should be coupled with a bluish green, while if a yellowish orange is used it should be coupled with a bluish purple. In practical designing it is not necessary to select exact complementary colors in order to produce harmonious contrasts, for it is generally considered better to combine hues that are 20 to 30 degrees on one side or the other of their complements, as the contrasts are not so strong.

In producing harmonious contrasts, it is a good plan to select colors that are at least 90 degrees apart on the chromatic circle. Colors that are from 30 to 90 degrees apart on the chromatic circle, such as red and orange, blue and purple, etc., do not, as a rule, form harmonious contrasts.

Fig. 155 shows a chromatic circle that gives the complementaries of the secondary and tertiary colors. Fig. 156 shows a color circle which illustrates how tints or pastel colors are formed. As previously stated, tints are formed by adding white to normal colors. In practice this effect of adding white is obtained by decreasing the amount of dye-stuff and using bleached material. The inner circle represents tints which are obtained from the saturated or normal colors in the outer circle by reducing them with white.

Fig. 157 shows a color circle which illustrates how tones are formed. As previously stated, tones are formed by adding black to normal colors. The inner circle represents tones which are obtained from the saturated or normal colors in the outer circle by adding black. A law of colors is that if the ornamenting shade is lighter than the ground color it will become brighter when combined with the ground color,

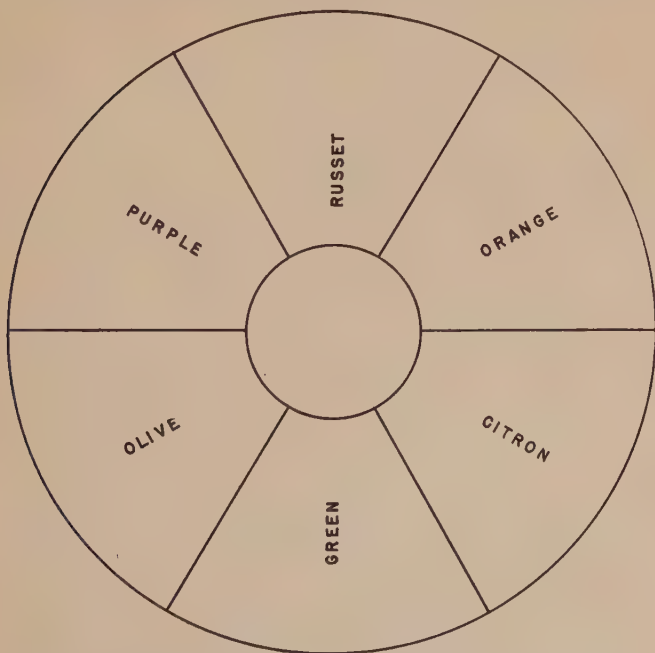


Fig. 155—Chromatic circle showing the complementaries of the secondary and tertiary colors.



Fig. 156—Color circle showing how tints are formed by adding white to the primary and secondary colors.

but it will suffer in tone if it is darker than the ground coloring. If two colors such as light and dark green were used together in the same fabric, the light color will appear lighter and the dark color will appear darker.

When dissimilar colors such as red and green, blue and yellow, red and blue are combined, they are said to be in color contrast. Colors which contain a common element or are alike, such as reddish orange and red, bluish green and green, are said to be in color analogy. In the same manner there is contrast of tone as in dark blue and light blue, or light green and dark red, and analogy of tone as in light blue and light yellow, mid-green and mid-blue, etc. Two colors may be in contrast both in color and shade or in analogy in both, or in contrast in one and in analogy in the other. In other words, contrast is that principle or quality

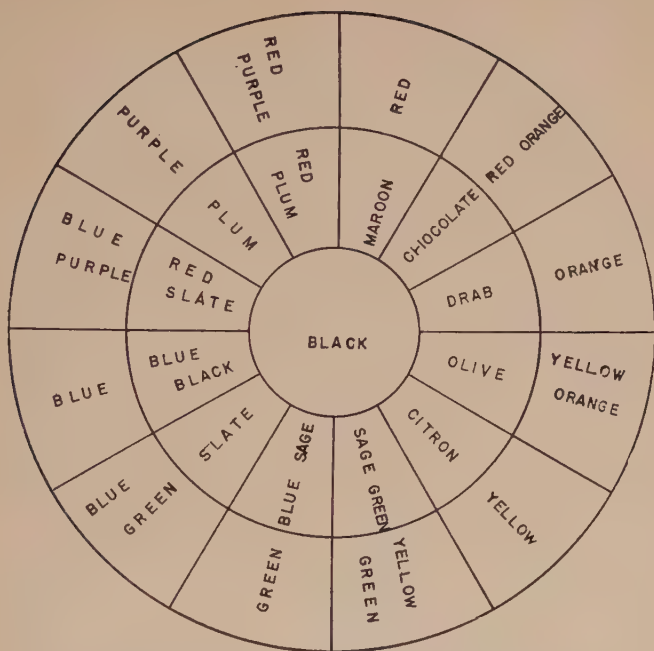


Fig. 157—Color circle showing how shades are formed by adding black to the primary and secondary colors.

of colors which produces a change in their lustre, depth, saturation and hue when in immediate contact with each other.

Contrast may be explained by considering the effect of black and gray yarns in a knitted fabric to which white is subsequently added. There is contrast in the pattern before the white is added but it lacks precision and force. The introduction of white gives lustre to the gray and fullness of tone to the black. Strictly speaking, neither the black nor the gray are changed by white. They are, as it were, developed by it. White, in this case, has the same function as in shaded drawings in which clearness and boldness are given to form and outline by increasing the dark element of some parts and the light element of others. What may be designated a tempered contrast occurs when a quantity of gray

separates areas of black and white. In the shading of a round surface this kind of contrast in neutral tints is developed to perfection. Undue harshness of effect is neutralized by the gradual toning of black into white. In the shading of angular objects, the sudden changes from the extreme light to the extreme dark end of the scale of shades, produce good illustrations of the characteristics of sharp contrasts. A pattern composed entirely of black and white yarns is full of this kind of contrast, but by adding gray a toning element is introduced which forms a mellow and tempered combination. Decided or hard contrasts resulting from the use of primary and secondary colors are exactly the reverse of graduated ones; they are lacking in softness which constitutes good coloring, but toned contrasts possess richness and mellowness. Contrasts obtained by combining pure colors may be harsh and displeasing to the eye. Red and blue, for example, form a strong color contrast, but this may be subdued by changing them to tints or tones.

In a satisfactory mixture of colors all hues contribute to the attractiveness of the whole, but in an imperfect contrast one or more colors may subtract from the luster of adjacent hues and partially neutralize their effect. When two or more contrasting colors are combined, the contrast may be successive or simultaneous. In successive contrasts the colors are such a distance apart that one color is seen after the other. The exhaustion of the color nerves causes a color, when looked at for some time, to appear duller, and in examining dyed fabrics, in order to avoid this defect, it is necessary to pass from one color to another, as for instance from red to green or olive, or to transfer the eyes at intervals to a color which is complimentary to the color of the fabrics. Fatigue has an effect upon the appearance of a color which is viewed immediately after another color has been observed. For instance, if red has been previously observed, blue appears greener, yellow appears greener, orange appears yellower, and green appears bluer. If yellow has been observed, red appears to have a purplish cast, blue appears to have a purplish cast, green appears bluer, and orange appears redder. Thus, when colors are observed one after

another, the term successive contrast is applied and it will be seen that the colors appear farther apart in the chromatic circle than they really are.

Fig. 158 is intended for illustrating successive contrast. The rectangle is divided into one-quarter inch spaces to be painted as follows: White in sections 1, 3, 5, 9, 11, 13, 15, 17, 19, and 21; Red in sections 2, 6, 10, 14, and 18; Orange in section 4; Yellow in section 8; Green in section 12; Blue in section 16; Purple in section 20.

In simultaneous contrast the colors are placed side by side, so that they are seen at the same time. The same law governs both successive and simultaneous contrasts and in each case the colors have the property of changing each other's qualities but the change is greater when the colors are in actual contact, or side by side, than when they are seen separately. Contrasting colors, placed side by side, are subject

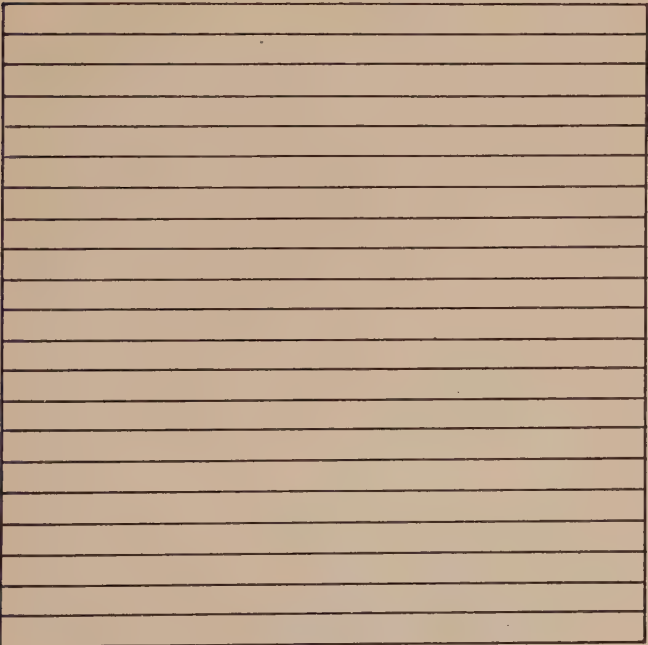


Fig. 158—Area for illustrating successive contrast.

to two kinds of contrast—contrast of hue, and contrast of tone. That is, they alter in hue or color and they alter in depth. In contrast of hue each color influences its adjacent color since *each appears to be tinged with the complimentary color of its neighbor*. Thus, in a cloth consisting of red and blue stripes, the red appears tinged with yellow, the complimentary of blue, and the blue appears tinged with bluish green which is the complimentary of red. Suppose that in a striped fabric the colors are arranged red, blue, red, green, blue, green, so that a blue stripe is formed first between two red stripes and then between two green stripes. The blue stripes, although made with yarn dyed in the same batch, would appear different, because in one case the blue is tinged with bluish green—the complement of red, and in the other case with reddish purple—the complement of green. One stripe of blue would thus appear greener and

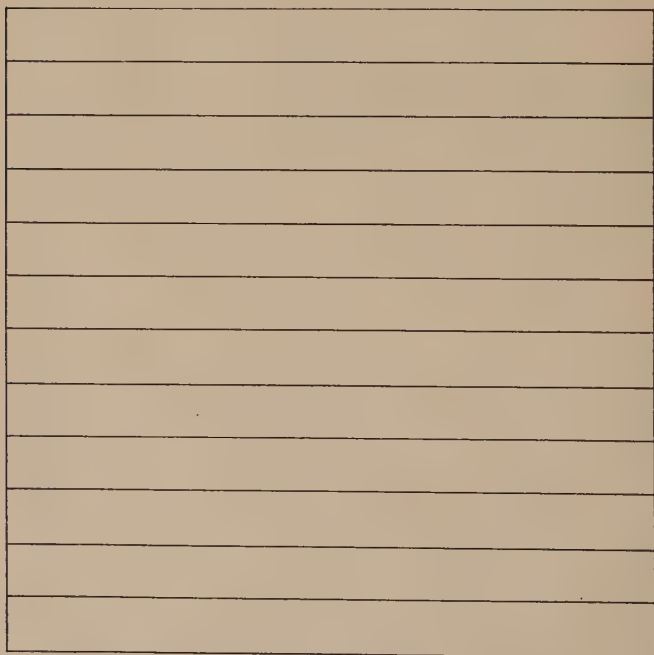


Fig. 159—Area for illustrating simultaneous contrast.

the other more violet. This is to be illustrated at Fig. 159.

The rectangle three inches high and three inches long is divided into one-half-inch sections. Paint sections 1 and 3 red, 2 and 5 blue, 4 and 6 green. The effect of simultaneous contrasts is to make adjacent colors appear farther apart in the chromatic circle. Simultaneous contrasts thus make the colors more unlike and when colors that are opposite in the circle are combined the contrast between them is strengthened and if properly proportioned both colors are enriched.

Contrast of tone or shade occurs (a) when two shades of the same color are placed side by side, as for instance, light blue and dark blue, and (b) when dark and light colors are used together, as for instance, dark blue and light green. The dark color by contrast makes the light color appear lighter than it really is, while similarly the light color makes the dark color appear darker than it actually is. On a white ground colors appear deeper and darker; on a gray ground they appear about normal, whereas on a dark ground they look brighter and lighter.

All types of color combinations may be classed under two heads: (a) Monochromatic, and (b) Polychromatic contrasts. Monochromatic contrasts are those in which different shades of the same color are combined, such as two tones of red, three tints of blue, etc. Softly graded contrasts result which are specially suitable for suitings, overcoatings and costumes. Polychromatic contrasts include all combinations of two or more colors which may be alike or different in tone, such as light green and dark red. Polychromatic contrasts form the strongest and most effective colorings, while monochromatic contrasts form soft subdued and graduated shadings. Combinations of red and green, yellow and blue, or orange and purple illustrate the principles of contrast due to combinations of colors, while blends of two shades of brown, blue or green form contrasts belonging to the monochromatic class. In textile design both types of contrast are used and both may be present in the same pattern. For instance, if two shades of brown forming the bulk of a pattern are brightened by extra threads of scarlet and blue, the pattern includes both classes of contrast.

Relatively considered contrasts in several colors are more definite and brilliant than contrasts in tones or tints, hence polychromatic contrasts are applied to all classes of decorative fabrics, while monochromatic contrasts constitute the bulk of the coloring in fabrics made for wearing apparel. Both systems of colorings overlap, making it impossible to limit the classes of fabrics in which each finds expression. Still, in the general run of styles tempered colors are the most appropriate for the ground or foundation of clothing fabrics, while bright and positive colors impart the most telling precision to ornamental form. Hence it may be said to be a common law in textile coloring that tones and tints compose a large proportion of styles intended for garments, whereas, the special province of hue contrasts is in the development of figured designs.

Color Harmony

Harmony of color is not governed by fixed principles, and any combination of hues that is pleasing and gives full satisfaction to the observer may be said to constitute harmony. The color sense in different persons, however, varies. It is more highly developed in some than in others—and what may appear harmonious to one may be more or less inharmonious to others. In combining colors the influence that one color has upon another should be carefully thought out, so that they may be arranged in such a manner that they will enhance and enrich, rather than impoverish each other. Harmony is obtained when the proper hues are so associated that every particle of color is helpful to the complete color scheme. It is usual to distinguish between two kinds of harmony: (1) harmony of analogy and (2) harmony of contrast.

Harmony of Analogy—There are two ways of producing harmony of analogy: (a) by the combination of tones of the same color that do not differ widely from each other; (b) by the combination of hues which are closely related and are equal or nearly equal in depth of tone. Different tints of blue, or shades of green when combined, yield a

"harmony of analogy of tone" if the difference between them is not too marked. Tone-shaded effects are produced by combining a series or scale of tones of a color which are so graded and arranged as to run insensibly one into another. In a combination of yellowish-green and bluish-green, yellow and blue are differentiating colors. There is a common element in green, and if the two hues are nearly equal in depth of tone, and are harmonious when united, they form a "harmony of analogy of hue." Harmonies of analogy are of value in producing quiet effects.

Harmony of Contrast—There are two ways of producing a harmony of contrast: (a) by the combination of widely different tones of the same color; (b) by the combination of unlike colors. Thus, a pleasing combination of two tones of blue, the interval between which is marked, forms a "harmony of contrast of tone," while the union of red and green, red and blue, or blue and yellow, if harmonious, forms in each case a "harmony of contrast of hue." Harmonies of contrast are useful when clear smart effects are required. As previously stated there may be analogy in tone and contrast in hue, or contrast in tone and analogy in hue in a combination.

There is also "harmony of succession—or gradation—of hue" (which partakes somewhat of both kinds of harmony) in which there is a succession of hues that pass insensibly one into the other. The spectrum is a typical example. Red and yellow, when combined are in color contrast but by introducing between them a series or scale of hues of orange, running from reddish-orange to yellowish-orange, the two colors may be so blended one into the other that there is no sharp contrast, and an effect closely related to harmony of analogy is produced. Similarly, yellow may be passed imperceptibly into blue through a series of hues of green, and blue into red through hues of violet and purple.

Basis of Color Harmony—Complementary hues are harmonious, but in their pure state they yield contrasts that are too strong. The colors still form similar complementary pairs when modified by means of black, or white, or both black and white, and in this condition they form most har-

monious combinations. A study of the complementary hues, and their shades, tints, and broken colors, is therefore of great value as an introduction to the combining of colors, and as a basis of color harmony. The painting out of color circles is a useful means of acquiring a knowledge of hues that harmonize, as colors that are opposite in the circles go well together except when they are too strong.

Color Spacing—While allowing for a predominating hue it is useful to arrange the spaces occupied by the several colors in a design in accordance with the relative intensity of the hue. Too great an excess of a color is injurious to an effect, and it is necessary to employ a strong color more sparingly than a less intense color. Thus, a combination of a shade of blue with intense yellow might be harmonious if the space occupied by the blue largely predominated, whereas with yellow predominating, the effect would be displeasing on account of the blue being overpowered by the greater luminosity of the yellow. In the same manner a few wales of bright red on a toned green foundation might prove pleasing where a large number of wales would appear crude.

In combining yarns which are in strong contrast, the space occupied by each hue or tone should be small, but if the contrast is subdued, the space allotted to each may be large. This is illustrated in a general way by the following lists in which the contrast is represented relatively by the terms black, gray, and white; the black and white producing a strong contrast, and the black, or white with gray more subdued effects, as the gray more nearly approaches the black or the white.

- | | | |
|-----|--------------------------|-----------------------|
| (a) | 2 courses black and | 2 courses white. |
| (b) | 4 " " " | 4 " light gray. |
| (c) | 8 " " " | 8 " mid gray. |
| (d) | 16 " " " | 16 " dark gray. |
| | | or |
| (e) | 2 courses white and | 2 courses black. |
| (f) | 4 " " " | 4 " dark gray. |
| (g) | 8 " " " | 8 " mid gray. |
| (h) | 16 " " " | 16 " light gray. |

Divisional Colors—In many combinations the contrast has the effect of making the colors appear blurred and confused at their joining. In such a case, and when the colors are too strong in contrast, hues of a neutral character, or black, gray, or white may be employed to separate the colors. The strength of the contrast is thereby reduced, and the colors are made to appear clear and precise. When a color is used to form the divisional line its qualities should be about intermediate between those of the two colors, or a paler tone of either color may be suitable. Black can always be successfully used to separate two bright colors, while white and gray are useful in separating a bright and a subdued color, or two subdued colors, grey being used instead of white when the latter forms too strong a contrast.

Although black is not so useful in separating a bright and a dark color as two bright colors, it can be successfully employed in combination with the dark colors, such as blue and violet, and the darker shades of the luminous colors in forming a harmony of analogy.

Choice of Colors for Plated Work

In the knitting of novelty hosiery and other types of knitted wear, one yarn is frequently plated over another. While the object sought is to have the plating yarn cover the backing yarn, this object is not always completely achieved. More often, the surface coloring will be affected by the backing yarn. This will be especially true where the plating yarn is of a transparent nature. It is thus possible for the color of the backing yarn to affect materially the character of the fabric. If the effect of the backing yarn is pronounced, it will be better to select yarns which blend well for use as plating and backing combinations. In such a combination, it is possible for the backing yarn to enrich the total effect rather than detract from it. Where complementary or highly contrasting colors are selected, the effect of the backing yarn will be too dull and detract from the richness of the plated surface.

COLOR HARMONY CHART

	Dk. Brown	Brown	Tan	Cream	Grey	Lavender	Purple	Helio	Maroon	Red	Pink	Orange	Yellow	Olive	Green	Pea Green	Myrtle Gr.	Navy Blue	Blue
Light Blue	BC	BC	GC	GC	GC	GB	GB	BB	BC	BC	GC	BC	BC	GC	BC	GB	GB	GB	GB
Blue	GC	GC	GC	GC	GC	GB	GB	GB	BC	BC	BC	BC	GC	GC	GC	GB	BB	GB	GB
Navy Blue	GC	GC	GC	GC	GC	GB	GB	GB	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Myrtle Gr.	GC	BC	GC	GC	GC	GB	GB	GB	GC	GC	GC	BC	GC	GC	GC	GB	GB	GB	GB
Pea Green	BC	GC	GC	GC	GC	GB	GB	GB	GC	GC	GC	BC	GC	GC	GC	GB	GB	GB	GB
Green	GC	GC	GC	GC	GC	GB	GB	GB	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Olive	GB	GB	GB	GB	BC	GC	GC	BC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Yellow	GB	GB	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Orange	GB	GB	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Pink	GB	GB	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Red	BC	BC	BC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Maroon	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Helio	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Purple	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Lavender	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Grey	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Cream	GB	GB	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GB	GB	GB	GB
Tan	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB
Grey	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB
Cream	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB
Tan	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB
Brown	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB	GB

GB=Good Blend
 BB=Bad Bland
 GC=Good Contrast
 BC=Bad Contrast

Color Harmony Chart

On the facing page is a color harmony chart which is useful in selecting colors which combine with good effect. The chart further shows whether the effect is a blend or a contrast. To use the chart, select any color and locate the line in the chart where this color appears. By following this line across the chart it is possible to determine which colors form good blends with it and also those colors which combine with it to give good contrasts.

